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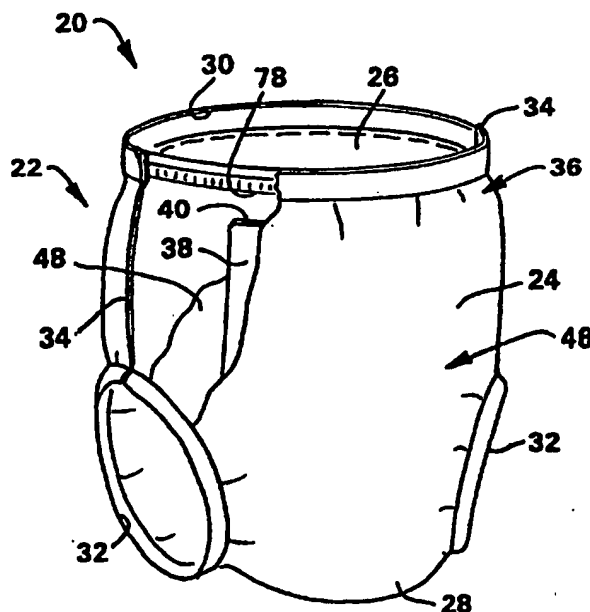
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(54) Title: **WAIST ELASTIC SYSTEM WITH IMPROVED ELASTIC DECAY PROPERTIES FOR A TRAINING PANT**

(57) Abstract

The present invention provides a child's disposable absorbent training pant having an improved waist elastic system. The waist elastic system has a selected maximum magnitude of decay over the first three cycles at a specific extension, thereby providing a substantially uniform low tension over a wide size range, a more comfortable fit, and improved ease of use.



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WAIST ELASTIC SYSTEM WITH IMPROVED ELASTIC DECAY PROPERTIES  
FOR A TRAINING PANT

Background of the Invention

5

The present invention pertains to disposable absorbent training pants for children, and more particularly to improved waist elastic systems therefor.

- 10 Current disposable absorbent training pants for children going through the potty training stage have proved to be a particularly desirable and useful product. This is especially true for the child, when he or she has outgrown, or believe they have outgrown, diapers. Diapers are for babies, and most children do not like being identified with or as babies.
- 15 Consequently, these children do not want to wear baby diapers, and instead prefer to wear a training pant that looks like adult underwear.

One problem with current training pants, however, is that they do not provide optimum comfort and ease of use, i.e., ease of pulling up or

20 pulling down, over a wide weight or size range and for an extended period of time. This discomfort, and difficulty in pulling up or pulling down, very often frustrates the child to the point that potty training is delayed due to the child's displeasure with and difficulty in using the product.

One reason current training pants do not provide optimum comfort and ease of use is the fact that one training pant size is intended for use by children within a particular range of weights or sizes. This requires a single size training pant to fit children with different size waists. In  
5 practice, this means that the training pant will not provide a substantially uniform low tension over the required waist size range. For example, one specific training pant size may be designed to fit children within a weight range of 25-35 pounds. This weight range includes a wide range of waist sizes. Generally, the training pant will fit one  
10 particular weight, i.e., intermediate waist size, well enough to provide some degree of satisfaction. However, at the low weight end, i.e., the smallest waist size, an elastic waistband must be used to gather the excess material at the waist opening. However, the tension provided by the retracted elastic waistband can be too high, thereby causing  
15 discomfort and/or difficulty in pulling the pant up or down for the smaller to intermediate size children.

At the high end of the weight range, where the waist size is largest, the elastic waistband will extend its maximum allowable length to accommodate  
20 the larger waist. However, when fully extended, it can exert too high of a tension against the child's waist. Again, this results in discomfort, possible redmarking, and difficulty in pulling the pant up and down, thereby delaying potty training.

25 Thus, the fact that a single size training pant is designed to fit wide weight ranges has prevented them from providing substantially uniform low tensions over the corresponding wide size ranges over an extended period

of time. Yet, this is an extremely desirable feature which, if available, would provide a training pant comfortable to the child, and easy to pull up or down. Thus, as a child would grow into, and then out of, a specified weight range for a specific training pant size, then the  
5 child would have a substantially uniform force or tension at the waist during that period of wearing the specific size training pant; but, this feature is not available in current children's disposable absorbent training pants.

10 Various designs of elastic waistbands have been used in these training pants, such as a single wide elastic member or a plurality of narrow elastic members. The waistbands may fully, or only partially, surround the waist opening. Generally, these elastic waistbands are incorporated by one of two methods. The first method incorporates the elastic  
15 waistbands when they are in an extended, tensioned state. The second method incorporates the elastic waistbands while they are in a relaxed, untensioned state. The latter method may require the use of a special elastic material, such as a heat-elasticizable material.

20 In both of these methods, the elastic waistbands generally are joined to multiple layers of material. For example, the elastic waistbands can be adhesively joined between two adjacent layers of material, such as, for example, the topsheet and backsheet of the training pant. In some cases, the elastic waistbands are first adhesively joined to a carrier sheet of  
25 material, and then the carrier sheet and elastic waistbands are adhesively joined between the adjacent layers.

The application of adhesive in these methods is generally accomplished by partially or totally coating the mutually facing surfaces of the adjacent layers, or by applying the adhesive in a bead to at least one of the layers. The latter method usually involves a continuous bead pattern, such as a wave-like pattern of adhesive.

Other methods or patterns for applying adhesive are available, and include joining the elastic waistbands along their full or entire length to multiple layers of material.

10

#### Summary of the Invention

In one form of the present invention there is provided a disposable absorbent training pant comprising a chassis including a front panel, a back panel, a crotch panel, and an absorbent structure on the crotch panel, in which the front and back panels, when joined together, form a waist opening and leg openings. A waist elastic system is provided about the waist opening, and has a maximum magnitude of decay of about 125 grams at an extension of about 300 millimeters over the first three cycles.

20

#### Description of the Drawings

The above-mentioned and other features of the present invention and the manner of attaining them will become more apparent, and the invention itself will be better understood by reference to the following description of the invention, taken in conjunction with the accompanying drawings, wherein:

25

Fig. 1 is a partially broken-away, front perspective view of a child's training pant incorporating the principles of the present invention;

- 5 Fig. 2 is a cross-section through the waist of the pant in Fig. 1 illustrating one embodiment of the present invention;

Fig. 3 illustrates another embodiment of the present invention;

- 10 Fig. 4 is a schematic diagram illustrating one method for making an embodiment similar to that in Fig. 3;

Figs. 5 and 6 schematically illustrate one method for making an embodiment similar to that in Fig. 2; and

15

Figs. 7-13 are graphs comparing the first three cycles of a training pant incorporating the principles of the present invention against the first three cycles of a current training pant product.

20 Definitions

Within the context of this specification, each term or phrase below includes the following meaning or meanings. These terms may be further defined, or used in conjunction with additional language to further  
25 expand their meaning, in the specification.

- (a) "Associated with" refers to the attachment of an elastic member, or elastic structure, to another element such that the elastic member,

or elastic structure, when attached to, placed with, or formed from the element, gives that element elastic properties. Thus, the joined elastic member and the other element exhibit elasticity.

- 5 (b) "Cycle" refers to an extension of an elastic member or elastic structure, and a retraction of the elastic member or elastic structure following the removal of the force causing the extension.
- (c) "Decay" refers to a loss of tension at a specific extension over a  
10 selected number of cycles.
- (d) "Disposable" refers to a garment, article, pant, or the like, that is designed to be used until soiled, either by urination, defecation, or otherwise, and then discarded, rather than being  
15 washed and reused again.
- (e) "Disposed", "disposed on", "disposed with", and variations thereof, refer to one element being integral or unitary with another element, or to one element being a separate structure joined to, connected  
20 to, placed with, or placed near another element.
- (f) "Elasticity" refers to the tendency of a material, or composite material, to recover its original size and shape after removal of the force causing a deformation. Elasticity may be expressed in  
25 percent.



(g) "Elongation" refers to the ratio of the extension of a material to the length of a material prior to the extension, and is represented by the formula: 
$$\frac{\text{extended length minus original length}}{\text{original length}} \times 100.$$

5

Elongation may be expressed as a percent.

(h) "Extension" or variations thereof refers to the change in length of a material due to stretching, and may be expressed in units of length.

10

(i) "Hysteresis" refers to a loss of tension over a specified number of cycles within a specified extension range.

15

(j) "Joining" or variations thereof refers to two or more elements being connected together in any suitable manner, such as by heat sealing, ultrasonic bonding, thermal bonding, adhesive bonding, stitching, or the like. The elements can be joined directly together, or may have one or more elements interposed between them, all of which are connected together.

20

(k) "Member" when used in the singular can have the dual meaning of a single element, or a plurality of elements.

25

(l) "Modulus of elasticity" refers to a constant that numerically measures or represents the amount of elasticity a material possesses.

- (m) "Retraction" or variations thereof refers to the decreasing change in length of an extended material upon removal of the force causing the extension.
- 5 (n) "Elongate sleeve member" refers to a structure having an elongate passage therein. The sleeve member can be formed by one layer of material folded upon itself, or two or more layers of material being selectively joined together, to form the elongate passage.
- 10 (o) "Tension" refers to a force tending to cause the extension of a body, or to the balancing force within that body resisting the extension. Tension may be expressed in units of grams.
- (p) "Waistborder" refers to a border about the waist opening of a  
15 training pant, and may be constructed of one or more layers of material.

#### Detailed Description

- 20 The present invention provides an improved waist elastic system for children's training pants that results in a substantially uniform low tension along the peripheral border of the waist opening over a wide size range, a more comfortable fit, and improved ease of use by the child over an extended period of use. This is accomplished by, among other things,
- 25 reducing the number of layers of material, i.e., the mass or amount of material, that the waist elastic system must gather. The more material there is to gather, the more the elasticity will be degraded or reduced in gathering the excess material. The present invention reduces this

number of layers or amount of material to be gathered by incorporating an elastic member in, for example, one layer of material, thereby reducing loss of elasticity.

- 5 The present invention selectively reduces the joined surface area, or the number of points of joinder, between an elastic member and its respective layer to which it is joined. For example, the elastic member may not be attached along its full length to the layer. The present invention provides a plurality of selectively spaced apart, distinct adhesive  
10 zones. By reducing the surface area of joinder between the elastic member and the layer of material, there is a resultant reduction in the elastic member's loss of elasticity.

- With reference to Fig. 1, a disposable absorbent training pant 20  
15 comprises a chassis 22 including a front panel 24, a back panel 26, a crotch panel 28, a waist opening 30, and a pair of leg openings 32. Openings 30, 32 are formed by selectively joining portions of front panel 24 and back panel 26 at side seams 34, which extend between waist opening 30 and a respective leg opening 32. Each side seam 34 can be formed in  
20 any suitable manner, such as by ultrasonic bonding, thermal bonding, adhesive bonding, or the like. A waist border 36 peripherally surrounds waist opening 30, and is formed upon joining front panel 24 and back panel 26 at seams 34.

- 25 Referring now to Figs. 1 and 2, chassis 22 includes an absorbent structure 38 disposed at least at crotch panel 28. Absorbent structure 38 includes an absorbent end edge 40, and has a length dimension 42 (Fig. 6) that is greater than a width dimension 44. Chassis 22 further

includes an outer cover layer 46 and a liner 48, which sandwich absorbent structure 38 therebetween. Liner 48 is desirably a single layer of liquid permeable material, but may also include other layers of material. Outer cover layer 46 is desirably a two-layer material that includes an  
5 outer layer 50, which can be made of a nonwoven liquid permeable material, and an inner layer 52, which can be made of a liquid impermeable material. Outer layer 50 and inner layer 52 can be joined together in any suitable manner, such as by adhesives 54. Liner 48 is desirably joined to outer cover layer 46 by adhesives 56, thereby  
10 sandwiching absorbent structure 38 therebetween. As described, chassis 22 is a multi-layer structure comprising outer cover layer 46 and liner 48.

Waist border 36 (Fig. 2) may also be a multi-layer structure comprising  
15 outer cover layer 46 and liner 48. Waist border 36 desirably includes an extension of one of the layers of chassis 22, for example, an extension of outer layer 50 (Fig. 2). This extension forms a peripheral edge portion 58 that peripherally surrounds waist opening 30.

20 Although described above with reference to a specific design and materials, training pant 20 can have other designs or constructions. Examples of other representative training pants are disclosed in U.S. Patent No. 4,940,464, the contents of which are incorporated by reference herein, and U.S. Patent No. 4,641,381, the contents of which are  
25 incorporated by reference herein.

Continuing to refer to Figs. 1 and 2, a separate waist elastic system 60 is associated with chassis 22 about waist opening 30. Waist elastic

system 60 includes an elongate sleeve member 62 defining therein an elongate passage 64, and an elongate elastic member 66. Elongate sleeve member 62 can be formed from one layer of material, such as a nonwoven liquid permeable material, by folding the material into a C-shape configuration comprising an outer surface 68 (Fig. 2) and an inner surface 70, which define elongate passage 64. Outer surface 68 and inner surface 70 can be joined together in any suitable manner, such as by adhesives 72. Adhesives 72 join only outer surface 68 and inner surface 70 together, and do not contact elongate elastic member 66, which is substantially freely movable in elongate passage 64.

Elongate sleeve member 62 is joined, such as by adhesives 74, to peripheral edge portion 58 (Fig. 2), such that the portion of sleeve member 62 containing elongate elastic member 66 extends outwardly beyond the end edge 59 of peripheral edge portion 58. Desirably, waist elastic system 60 is joined to only one of the layers comprising chassis 22, such as outer layer 50, for purposes that will be explained hereafter. Within elongate passage 64, elongate elastic member 66 has an outermost peripheral edge 76, and an innermost peripheral edge 78 that is spaced a selective distance from absorbent end edge 40. Although elongate elastic member 66 is illustrated in Fig. 2 as a single ribbon of elastic material, it may comprise a plurality of elastic ribbons or strands. In the case in which elongate elastic member 66 is a plurality of strands or ribbons, outermost peripheral edge 76 will correspond to the outermost peripheral edge of the outermost strand or ribbon, and innermost peripheral edge 78 will correspond to the innermost peripheral edge of the innermost strand or ribbon.

Since waist elastic system 60 is a separate structure from chassis 22, waist elastic system 60 can be made and constructed of any types of desired material independent of the materials of which chassis 22 is made. This provides increased flexibility in the design and construction  
5 of waist elastic system 60.

In one embodiment, hereinafter also referred to as Embodiment 1, of disposable absorbent training pant 20, outer cover layer 46 comprises an outer layer 50 made of a liquid permeable spunbond polypropylene web  
10 having a basis weight of about 20 grams per square meter, and an inner layer 52 made of a 0.0015 centimeter polyethylene film. Liner 48 can be made of the same material as outer layer 50 and made hydrophilic by treating it with a wettable agent, or can be made of a hydrophilic material. Absorbent structure 38 can comprise a uniform mixture of any  
15 suitable superabsorbent material and wood pulp fluff, with the mixture enclosed in a tissue wrap to maintain the integrity of the superabsorbent material and fluff. Sleeve member 62 can be made of a nonwoven web of bicomponent fibers in a side-by-side orientation, in which the fibers are present in the amount of about 50 percent polypropylene fibers to about  
20 50 percent polyethylene fibers. Sleeve member 62 desirably has a basis weight of about 17 gsm, and is constructed in a C-fold configuration to have a width of about 2.38 centimeters (15/16 inch) and a relaxed length of about 73.66 centimeters (29 inches), i.e., a circumferential length of about 73.66 centimeters. Elastic member 66 is made of a natural rubber  
25 material, and has a thickness of about 7 mils, a width of about 0.79 centimeters (5/16 inch), and a relaxed circumferential length of about 28.58 centimeters (11.25 inches). One process of constructing a waist elastic system 60 includes providing two lengths of natural rubber having

respective relaxed lengths of about 14.28 centimeters (5-5/8 inches) (one-half of the relaxed circumferential length) and two lengths of the above-described nonwoven web having respective relaxed lengths of about 36.83 centimeters (14.5 inches). Each natural rubber length has a width of 0.79 centimeters (5/16 inch), and each nonwoven web length has a width of about 4.83 centimeters (1.9 inches) (twice the C-fold configuration width of 15/16 inch). Both natural rubber lengths are extended about 36.83 centimeters (14.5 inches) and placed on a respective nonwoven web length having a length of about 36.83 centimeters, with the ends of each natural rubber length being joined to the ends of its respective nonwoven web length. Each nonwoven web length is C-folded over its respective natural rubber length. The two resulting composites, comprising a natural rubber length and a nonwoven web length, are joined at their ends to form a closed-loop elastic waistband, such as a waist elastic system 60. The composites can be joined together in a relaxed state or extended state. The closed-loop elastic waistband has, in its relaxed state, a circumferential length of about 73.66 centimeters (29 inches).

Elongate sleeve member 62 and elongate elastic member 66 also can be joined to chassis 22 at seams 34 at the same time front panel 24 and back panel 26 are joined to form seams 34. Thus, between seams 34 (Fig. 1), elastic member 66 is freely movable within passage 64.

Waist elastic system 60 provides the features of a substantially uniform low tension over a wide size range, a more comfortable fit, and improved ease of use, over repeated uses of training pant 20. A repeated use refers, for example, to the child pulling the pant down to go to the bathroom, or pulling the pant up. It has been discovered that this type

of repeated use with current training pants results in a substantial loss of elasticity about waist opening 30. To address this loss of elasticity over repeated uses, current training pants incorporate the waist elastic with a relatively high tension for the purpose of compensating for this  
5 loss of elasticity over repeated use. However, this relatively high tension of the waist elastic results in an uncomfortable fit, redmarking, and/or difficulty in pulling the pant up or down, all of which are undesirable to both the child and the parent or caretaker.

10 In analyzing this discovered problem, applicants have found that one important factor relating to these desired features is the average maximum rate of change of modulus of elasticity over the first three cycles, which will be described in greater detail below. Figs. 7-13 compare the first three cycles of use of Embodiment 1 against a current  
15 training pant. A cycle represents one extension and one retraction of the waist elastic, which occurs generally when the child pulls the pant upwardly or pulls the pant downwardly. In Fig. 7, the first three cycles of Embodiment 1 are represented by the curves identified as cycle 1, cycle 2, and cycle 3. Cycle 1 comprises an extension E1 and a retraction  
20 R1, in which extension E1 begins at point A and ends at point B, and retraction R1 begins at point B and ends at point C. Each point A, B, and C represents a specific tension in grams at a specific extension in millimeters. Cycle 2 has an extension E2 and a retraction R2, and cycle 3 has an extension E3 and a retraction R3.

25

In comparison to the three cycles 1, 2, and 3 are the first three cycles 1', 2', and 3', of a current training pant, identified as Sample 1. When comparing cycles 1, 2, and 3 to cycles 1', 2', and 3' of Sample 1, the



Sample 1 cycles 1', 2', and 3' have a much higher tension in grams over the extension range of 175 to 325 millimeters than cycles 1, 2, and 3. When taken over a range of extension of about 175-325 millimeters, Embodiment 1 provides a substantially more uniform, lower tension for the  
5 first three cycles than Sample 1.

Figs. 8-13 are similar to Fig. 7, in that each of the Figs. 8-13 compares the first three cycles 1, 2, and 3 of Embodiment 1 with the first three cycles 1', 2', and 3' of Samples 2-7, respectively. Note that the scales  
10 of the Y-axes, which represent the load or tension in grams, are different in Figs. 7-13 in order to more clearly illustrate the comparisons.

Sample 1 (Fig. 7) was manufactured by The Drypers Corporation, is  
15 generally identified as Big Boy and Big Girl product, and was obtained from a product package having a bag count of 13 for boys and girls weighing up to 36 pounds.

Sample 2 (Fig. 8) was manufactured by Kimberly-Clark Corporation, is  
20 identified as HUGGIES® PULL-UPS® brand training pant product, and was obtained from a product package having a bag count of 16 for boys weighing 29-36 pounds and girls weighing 25-34 pounds.

Sample 3 (Fig. 9) was manufactured by Paragon Trade Brands, is generally  
25 identified as Kids Pants product, and was obtained from a product package having a bag count of 20 for boys and girls in the 24-33 pound weight range.

Sample 4 (Fig. 10) was manufactured by The Procter & Gamble Company, is generally identified as Pampers® Trainers® product, and was obtained from a product package having a bag count of 16 for boys and girls weighing 23-34 pounds.

5

Sample 5 (Fig. 11) was manufactured by Pope & Talbot, is generally sold through the Vons store chain, and was obtained from a product package having a bag count of 16 for boys and girls weighing 27-36 pounds.

10 Sample 6 (Fig. 12) was manufactured by Molnlycke Consumer Products AB, is generally identified as Libero Up & Go product, and was obtained from a product package having a bag count of 22 for boys and girls weighing 20-33 pounds (9-15 kilograms).

15 Sample 7 (Fig. 13) was manufactured by the Uni-Charm Corporation, is generally identified as Oyasumi Man product, and was obtained from a product package having a box count of 8 for boys and girls in the size range of 85-105 centimeters.

20 All products representing Samples 1-7 were commercially purchased in late 1994 or early 1995.

With regard to the description herein, a modulus of elasticity is a constant that numerically measures how much elasticity a material possesses, such as waist elastic system 60. A constant, with reference to Fig. 7, for example, is the slope represented by any two points on a curve of any one of the illustrated cycles. An average maximum rate of change of modulus of elasticity is calculated by averaging a selected

number of slopes taken at specified points of a particular curve. Each curve of each cycle, and this includes the portion representing the extension and the portion representing the retraction in the cycle, had a slope calculated at every 25 millimeter increment within the extension range of 175 millimeters to 325 millimeters. The lower average slope, whether during an extension, a retraction, or a cycle, of Embodiment 1 in comparison to the higher average slope of any of the Samples 1-7, indicates a substantially lower rate of increase in tension over a wide size range than any of the Samples 1-7.

10

The average maximum rates of change of modulus of elasticity over the first three cycles are calculated from the data presented in Tables 1-9.

TABLE 1

## EMBODIMENT 1

		TENSION (grams)					Average (g)	Slope (g/mm)
Extension/Retraction (mm)		Specimen 1	Specimen 2	Specimen 3	Specimen 4	Specimen 5		
Extension 1	175	104.57	120.15	122.37	102.35	115.70	113.03	2.10
	200	155.75	171.32	178.00	149.07	173.55	165.54	1.78
	225	198.02	213.60	220.27	198.02	220.27	210.04	1.58
	250	235.95	251.42	262.55	233.62	264.77	249.64	1.42
	275	267.00	289.24	300.37	267.00	302.69	285.24	1.53
	300	302.59	329.29	342.64	300.37	342.64	323.51	1.55
	325	340.42	371.57	382.69	335.97	380.47	362.22	
Retraction 1	325	340.42	371.57	382.69	335.97	380.47	362.22	3.33
	300	264.77	278.12	284.80	267.00	300.37	279.01	1.87
	275	220.27	231.40	238.07	220.27	251.42	232.29	1.41
	250	188.90	185.80	200.25	189.12	213.60	197.13	1.44
	225	149.07	160.20	166.57	151.30	178.00	161.00	1.39
	200	115.70	128.82	133.50	120.15	135.72	128.38	2.05
	175	68.97	77.87	77.87	68.97	82.32	75.20	
Extension 2	175	77.87	91.22	93.45	77.87	93.45	86.77	2.14
	200	131.27	142.40	146.85	131.27	146.07	140.17	1.71
	225	173.55	182.45	189.12	171.32	198.02	182.69	1.35
	250	208.92	218.05	220.27	204.70	233.62	216.71	1.50
	275	240.30	253.85	262.55	240.30	273.67	254.00	1.57
	300	278.12	291.47	304.82	275.90	318.94	293.25	1.69
	325	320.39	338.19	347.09	311.49	360.44	335.52	
Retraction 2	325	320.39	338.19	347.09	311.49	360.44	335.52	2.71
	300	255.87	269.22	273.67	253.65	287.02	267.89	1.76
	275	213.60	220.27	229.17	213.60	242.52	223.63	1.30
	250	180.22	191.35	195.80	182.45	208.92	191.35	1.32
	225	149.07	160.20	162.42	149.07	171.32	158.42	1.46
	200	113.47	122.37	126.82	115.70	131.27	121.03	1.90
	175	68.97	77.87	77.87	68.97	77.87	74.31	
Extension 3	175	75.85	86.77	91.22	75.85	91.22	84.10	2.10
	200	126.82	137.95	140.17	129.05	149.07	136.61	1.78
	225	169.10	182.45	184.67	171.32	195.80	180.67	1.37
	250	202.47	215.62	220.27	204.70	231.40	214.93	1.33
	275	233.62	249.20	253.85	235.85	269.22	248.31	1.53
	300	271.45	289.24	293.69	271.45	307.04	286.58	1.67
	325	309.27	331.52	344.87	307.04	349.32	328.40	
Retraction 3	325	309.27	331.52	344.87	307.04	349.32	328.40	2.56
	300	249.20	264.77	271.45	251.42	284.60	264.33	1.67
	275	211.37	218.05	229.17	213.60	240.30	222.50	1.30
	250	178.00	189.12	195.80	182.45	204.70	190.01	1.35
	225	146.85	153.52	162.42	149.07	169.10	156.19	1.41
	200	113.47	120.15	124.60	117.92	129.05	121.04	1.92
	175	68.75	75.85	75.85	68.97	77.87	72.98	

**TABLE 2****EMBODIMENT 2**

Extension/Retraction (mm)		TENSION (grams)					Average (g)	Slope (g/mm)
		Specimen 1	Specimen 2	Specimen 3	Specimen 4	Specimen 5		
Extension 1	175	133.50	113.47	104.57	122.37	100.80	110.14	2.37
	200	191.35	171.32	162.42	182.45	169.10	175.33	1.96
	225	238.07	220.27	209.15	233.62	220.27	224.28	1.85
	250	282.67	267.90	253.65	280.35	269.22	270.56	1.67
	275	324.64	307.04	291.47	322.62	315.94	312.38	1.80
	300	373.79	351.54	333.74	387.12	360.44	357.33	1.96
Retraction 1	325	418.29	402.72	378.24	420.52	411.62	406.28	
	300	362.59	291.47	282.57	307.04	291.47	295.03	4.45
	275	249.20	240.30	233.62	253.65	238.07	242.97	2.08
	250	211.37	202.47	193.57	215.82	199.02	204.25	1.53
	225	171.32	168.87	155.75	173.55	160.20	163.64	1.55
	200	131.27	126.82	115.70	131.27	117.02	124.60	1.64
Extension 2	175	77.87	73.42	64.52	77.87	66.75	72.09	2.10
	200	100.12	86.77	77.87	91.22	80.10	87.22	
	225	149.07	144.62	135.72	149.07	140.17	143.73	2.26
	250	188.02	185.90	180.22	188.02	184.67	186.57	1.83
	275	238.07	224.72	220.27	240.30	222.50	229.17	1.58
	300	278.12	264.77	255.67	280.35	267.00	269.22	1.60
Retraction 2	325	327.07	315.94	298.14	329.29	315.94	317.28	1.92
	300	378.24	362.67	344.67	380.47	362.67	365.78	1.94
	275	291.47	280.35	271.45	291.47	280.35	283.02	
	250	240.30	231.40	222.50	244.75	231.40	234.07	3.31
	225	202.47	189.02	189.12	206.92	193.57	198.02	1.96
	200	166.67	162.42	149.07	169.10	153.52	160.20	1.44
Extension 3	175	129.05	122.37	113.47	126.82	113.47	121.04	1.51
	200	75.65	71.20	62.30	73.42	64.52	69.42	1.57
	225	83.45	84.55	75.65	86.77	75.65	83.21	2.06
	250	149.07	140.17	133.50	149.07	133.50	141.68	
	275	183.57	182.45	175.77	188.02	182.45	186.45	2.31
	300	233.62	220.27	213.60	233.62	220.27	224.28	1.82
Retraction 3	325	271.45	260.32	246.97	275.90	258.10	262.55	1.51
	300	318.17	307.04	291.47	320.39	307.04	308.62	1.53
	275	364.89	360.44	335.97	369.34	356.22	357.77	1.85
	250	384.89	380.44	335.97	369.34	356.22	357.77	1.96
	225	267.02	278.12	269.22	291.47	275.90	280.35	
	200	240.30	233.62	220.27	244.75	229.17	233.62	3.10
Extension 4	175	202.47	195.60	189.12	206.92	191.35	197.13	1.67
	200	166.67	160.20	149.07	169.10	149.07	158.66	1.46
	225	126.82	122.37	109.02	124.60	113.47	119.26	1.53
	250	75.65	66.75	60.07	71.20	60.07	66.75	1.58
	275	100.12	86.77	77.87	91.22	80.10	87.22	2.10
	300	149.07	144.62	135.72	149.07	140.17	143.73	

**TABLE 3****SAMPLE 1**

Extension/Retraction (mm)		TENSION (grams)					Average (g)	Slope (g/mm)
		Specimen 1	Specimen 2	Specimen 3	Specimen 4	Specimen 5		
Extension 1	175	181.35	209.15	183.57	188.02	181.35	186.69	2.95
	200	262.55	282.57	269.22	273.67	264.77	270.56	2.67
	225	327.07	349.32	338.19	342.64	329.29	337.30	2.92
	250	396.04	424.97	411.82	418.29	400.49	410.28	4.08
	275	489.49	538.44	511.74	527.32	483.94	512.19	8.67
	300	678.61	829.91	696.41	780.84	678.61	728.90	44.65
	325	1677.82	2159.33	1835.35	2147.09	1806.42	1845.16	
Retraction 1	325	1677.82	2159.33	1835.35	2147.09	1806.42	1845.16	55.37
	300	449.44	471.69	462.79	485.02	458.12	461.01	4.13
	275	351.54	382.67	358.22	362.67	353.77	357.77	2.49
	250	289.24	298.14	295.92	298.14	295.92	295.47	2.21
	225	233.82	244.75	240.30	242.52	240.30	240.30	2.37
	200	175.77	184.67	180.22	182.45	182.45	181.11	2.74
	175	108.89	117.82	111.25	113.47	113.47	112.58	
Extension 2	175	148.85	155.75	148.85	149.07	151.30	149.96	3.83
	200	222.50	231.40	224.72	224.72	224.72	225.01	2.80
	225	284.80	295.92	291.47	295.92	284.80	290.58	2.74
	250	351.54	367.12	358.22	364.89	353.77	359.11	3.38
	275	431.84	453.89	444.99	453.89	433.87	443.66	6.57
	300	589.61	638.56	616.31	634.11	598.51	615.42	47.83
	325	1688.75	1824.47	1415.08	2296.18	1831.14	1811.12	
Retraction 2	325	1688.75	1824.47	1415.08	2296.18	1831.14	1811.12	54.45
	300	440.54	458.12	451.67	453.89	447.22	448.89	3.93
	275	347.09	353.77	351.54	353.77	351.54	351.54	2.47
	250	282.57	291.47	291.47	291.47	291.47	289.69	2.14
	225	231.40	238.07	235.85	238.07	238.07	238.29	2.33
	200	173.53	180.22	175.77	178.00	182.45	178.00	2.76
	175	104.57	115.70	108.89	108.89	111.25	109.02	
Extension 3	175	137.85	149.07	140.17	140.17	140.17	141.51	3.06
	200	211.37	224.72	220.27	220.27	213.60	218.65	2.60
	225	282.57	287.02	282.57	291.47	282.57	285.24	2.69
	250	348.32	353.77	353.77	353.77	351.54	352.43	3.44
	275	431.84	449.44	436.09	442.77	431.84	438.32	6.34
	300	574.04	614.09	596.29	614.09	585.16	596.73	42.69
	325	1639.80	1888.75	1383.90	2239.42	1388.38	1864.05	
Retraction 3	325	1639.80	1888.75	1383.90	2239.42	1388.38	1864.05	48.78
	300	436.09	449.44	447.22	449.44	442.77	444.99	3.84
	275	344.87	349.32	349.32	351.54	349.32	348.87	2.58
	250	282.57	284.80	284.80	282.57	287.02	284.35	2.05
	225	226.95	235.85	233.82	233.82	235.85	233.18	2.30
	200	169.10	178.00	175.77	175.77	180.22	175.77	2.79
	175	102.35	111.25	102.35	104.57	109.02	105.81	

TABLE 4

SAMPLE 2

Extension/Retraction (mm)		TENSION (grams)					Average (g)	Slope (g/mm)
		Specimen 1	Specimen 2	Specimen 3	Specimen 4	Specimen 5		
Extension 1	175	-4.45	-2.22	-2.22	-2.22	-2.22	-2.97	3.03
	200	71.18	73.41	82.31	68.86	68.86	72.90	4.88
	225	182.41	189.88	200.20	180.18	183.75	189.53	3.47
	250	294.71	278.96	288.96	282.49	285.18	278.28	2.97
	275	322.85	349.24	351.47	327.00	384.81	343.01	2.51
	300	378.84	418.88	413.75	384.83	438.22	405.75	2.51
	325	438.00	478.04	480.49	444.90	504.96	488.48	
Retraction 1	325	438.00	478.04	480.49	444.90	504.96	488.48	8.01
	300	242.47	278.84	278.84	258.82	291.41	268.87	3.51
	275	182.16	188.88	184.83	173.51	187.88	180.83	2.84
	250	102.33	122.35	120.12	113.45	120.80	117.01	2.54
	225	44.48	58.81	57.84	53.89	55.81	53.89	2.24
	200	-8.80	-2.22	0.00	0.00	-2.22	-2.87	0.04
	175	-11.12	-2.22	-2.22	-2.22	0.00	-3.58	
Extension 2	175	-11.12	-2.22	-2.22	-2.22	-2.22	-4.00	0.75
	200	11.12	15.57	17.80	15.57	13.35	14.88	3.97
	225	97.88	117.90	122.33	108.78	124.57	113.89	2.88
	250	184.01	183.83	189.08	180.18	202.43	185.97	2.82
	275	228.90	258.84	258.82	242.47	273.81	251.37	3.31
	300	304.75	342.57	348.35	320.33	382.88	334.12	4.43
	325	422.85	444.90	447.12	438.00	473.81	444.90	
Retraction 2	325	422.85	444.90	447.12	438.00	473.81	444.90	7.44
	300	233.57	288.84	284.71	249.14	288.28	258.83	3.38
	275	155.71	180.18	177.88	168.06	181.31	174.84	2.80
	250	65.85	113.45	113.45	108.78	120.12	109.89	2.51
	225	37.82	48.84	51.16	46.71	51.16	47.18	2.05
	200	-11.12	-2.22	-2.22	-2.22	-2.22	-4.00	-0.82
	175	-11.12	-2.22	0.00	-2.22	-2.22	-3.58	
Extension 3	175	-11.12	-2.22	-2.22	-2.22	-2.22	-4.00	0.83
	200	2.22	8.80	17.80	11.12	8.87	9.34	3.75
	225	88.88	108.00	111.22	87.88	108.00	103.22	2.89
	250	180.16	182.41	182.41	171.28	183.83	177.96	2.47
	275	215.77	248.82	244.89	229.12	282.49	238.80	3.22
	300	291.41	327.00	327.00	308.88	348.24	320.33	4.88
	325	411.53	431.85	438.00	424.88	480.49	438.89	
Retraction 3	325	411.53	431.85	438.00	424.88	480.49	438.89	7.28
	300	229.12	282.49	280.29	244.89	278.00	254.89	3.31
	275	151.28	177.88	178.73	188.84	188.88	172.17	2.80
	250	81.20	111.22	111.22	104.85	117.90	107.22	2.54
	225	35.59	44.48	48.71	44.48	48.71	43.80	1.89
	200	-11.12	-2.22	-2.22	-2.22	0.00	-8.88	-0.82
	175	-11.12	0.00	-2.22	-2.22	0.00	-3.11	

**TABLE 5****SAMPLE 3**

		TENSION (grams)					Average (g)	Slope (g/mm)
Extension/Retraction (mm)		Specimen 1	Specimen 2	Specimen 3	Specimen 4	Specimen 5		
Extension 1	175	422.65	447.12	453.79	580.39	358.14	412.42	7.76
	200	627.30	654.00	665.12	553.90	531.65	606.39	7.55
	225	838.63	851.98	858.42	718.51	709.61	795.03	9.13
	250	1094.44	1098.89	1096.67	909.81	916.49	1023.28	11.98
	275	1412.54	1421.44	1419.32	1161.18	1167.85	1314.67	15.70
	300	1825.19	1851.88	1822.86	1523.77	1512.65	1707.29	19.81
	325	2335.70	2365.73	2327.92	1995.36	1987.57	2202.46	
Retraction 1	325	2335.70	2365.73	2327.92	1995.36	1987.57	2202.46	50.73
	300	947.63	964.34	949.89	880.67	878.67	934.28	13.78
	275	587.26	638.20	625.08	540.55	558.34	589.49	7.67
	250	395.96	431.55	424.68	362.59	373.71	397.74	5.50
	225	258.04	286.99	282.51	233.57	240.24	260.26	4.63
	200	144.59	164.61	164.61	124.57	124.57	144.59	4.00
	175	48.94	60.06	57.84	28.92	28.99	44.49	
Extension 2	175	184.61	173.51	180.18	126.80	126.80	164.38	9.10
	200	315.88	333.67	331.45	273.61	280.28	308.88	5.82
	225	462.69	496.06	480.49	404.96	418.20	452.46	6.92
	250	631.75	676.24	669.57	571.69	578.36	625.52	9.72
	275	874.22	932.06	925.38	791.91	818.61	868.44	16.19
	300	1296.87	1363.61	1354.71	1161.18	1190.10	1273.29	28.15
	325	2044.30	2106.58	2064.32	1772.91	1897.48	1977.12	
Retraction 2	325	2044.30	2106.58	2064.32	1772.91	1897.48	1977.12	43.48
	300	896.47	949.85	940.95	820.83	843.08	890.24	12.94
	275	562.79	611.73	602.83	518.30	538.32	568.60	7.46
	250	378.16	413.75	411.53	342.57	355.02	360.23	5.30
	225	246.92	273.61	271.39	220.22	226.90	247.81	4.64
	200	133.47	149.04	155.71	109.00	111.22	131.69	3.95
	175	35.59	46.71	44.49	17.80	20.02	32.92	
Extension 3	175	140.14	155.71	160.18	106.78	109.00	134.38	6.26
	200	291.41	313.65	322.55	294.71	292.49	290.96	5.64
	225	431.55	471.59	462.69	395.98	398.18	431.99	6.84
	250	605.06	642.87	633.98	542.77	565.02	597.94	9.08
	275	840.85	880.89	872.00	751.67	778.57	824.84	15.13
	300	1241.26	1283.52	1267.95	1094.44	1127.81	1203.00	28.09
	325	1936.41	2002.03	1951.98	1614.06	1821.85	1905.27	
Retraction 3	325	1936.41	2002.03	1951.98	1614.06	1821.85	1905.27	41.51
	300	865.32	927.61	914.26	803.04	827.51	867.55	12.47
	275	551.67	596.38	587.26	511.63	529.43	555.67	7.39
	250	367.04	404.86	395.96	338.12	349.24	371.04	5.27
	225	238.02	264.71	269.26	215.77	218.00	239.35	4.59
	200	124.57	144.59	142.37	104.55	106.78	124.57	3.83
	175	31.14	44.49	40.04	18.57	13.35	28.92	



**TABLE 6****SAMPLE 4**

Extension/Retraction (mm)		TENSION (grams)					Average (g)	Slope (g/mm)
		Specimen 1	Specimen 2	Specimen 3	Specimen 4	Specimen 5		
Extension 1	175	-2.22	-2.22	-4.45	2.22	-2.22	-1.78	5.58
	200	128.91	153.38	128.91	148.91	128.91	137.80	8.05
	225	322.27	342.27	340.05	353.39	337.83	339.16	6.17
	250	473.40	484.82	502.30	513.41	493.41	483.41	5.32
	275	602.31	602.31	644.54	657.88	624.54	626.32	5.39
	300	742.33	731.22	782.34	783.45	755.67	761.00	4.57
	325	880.13	840.13	868.80	915.69	873.48	875.24	
Retraction 1	325	880.13	840.13	868.80	915.69	873.48	875.24	12.18
	300	557.88	560.08	575.84	588.75	573.42	570.75	8.49
	275	400.06	404.50	411.17	420.06	406.73	408.51	5.57
	250	262.26	271.15	268.93	277.82	266.71	269.37	5.49
	225	128.91	140.02	128.91	135.58	126.69	132.02	4.98
	200	4.45	13.34	2.22	13.34	4.45	7.56	0.48
	175	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	
Extension 2	175	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	2.08
	200	42.23	62.23	37.78	51.12	44.45	47.56	7.11
	225	215.59	233.37	220.63	228.92	228.92	225.37	5.97
	250	371.17	373.39	388.94	386.72	373.39	374.72	5.42
	275	500.07	508.74	513.41	522.30	508.96	510.30	5.87
	300	644.54	642.32	662.32	677.88	657.88	656.86	6.65
	325	806.79	783.45	826.79	849.02	840.13	823.23	
Retraction 2	325	806.79	783.45	826.79	849.02	840.13	823.23	10.92
	300	537.88	551.19	553.42	562.31	546.75	550.30	8.37
	275	384.50	388.95	393.39	397.84	391.17	391.17	5.44
	250	248.93	257.82	255.59	262.26	251.15	255.15	5.41
	225	117.80	126.69	117.80	124.46	113.35	120.02	4.69
	200	0.00	6.67	0.00	8.89	-2.22	2.67	0.20
	175	-2.22	-2.22	-2.22	-2.22	-2.22	-2.22	
Extension 3	175	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	1.51
	200	33.34	46.67	24.45	40.01	22.23	33.34	7.25
	225	204.47	228.92	204.47	224.48	211.14	214.70	6.80
	250	348.72	364.50	360.05	368.94	357.83	359.61	5.21
	275	482.29	488.74	493.41	500.07	488.74	489.85	5.71
	300	624.54	622.31	635.65	648.99	631.21	632.54	6.70
	325	784.56	800.12	802.34	822.34	791.23	800.12	
Retraction 3	325	784.56	800.12	802.34	822.34	791.23	800.12	10.49
	300	531.19	528.97	542.30	551.19	535.64	537.86	6.15
	275	377.83	382.26	384.50	393.39	382.28	384.06	5.41
	250	244.48	248.93	248.93	257.82	244.48	248.93	5.35
	225	113.35	122.24	111.13	120.02	108.91	115.13	4.59
	200	0.00	2.22	-4.45	6.67	-2.22	0.44	0.12
	175	-4.45	-2.22	-2.22	-2.22	-2.22	-2.67	

**TABLE 7****SAMPLE 5**

		TENSION (grams)					Average (g)	Slope (g/mm)
Extension/Retraction (mm)		Specimen 1	Specimen 2	Specimen 3	Specimen 4	Specimen 5		
Extension 1	175	229.17	253.65	238.07	242.52	229.17	236.82	2.83
	200	298.14	318.17	307.04	304.82	293.69	304.37	2.55
	225	362.67	380.47	376.02	367.12	353.77	368.01	3.10
	250	438.32	458.34	456.12	440.54	433.87	445.44	4.33
	275	542.89	565.14	571.82	545.12	542.89	553.57	8.37
	300	734.24	772.08	814.34	738.46	756.49	762.72	36.07
	325	1588.62	1706.55	1775.52	1461.80	1789.98	1684.49	
Retraction 1	325	1588.62	1706.55	1775.52	1461.80	1789.98	1684.49	48.25
	300	462.79	469.47	451.67	449.44	458.34	458.34	4.86
	275	340.42	347.09	331.52	331.52	333.74	336.88	2.35
	250	282.57	284.80	273.67	273.67	275.90	278.12	1.57
	225	242.62	246.97	233.62	235.85	235.85	238.96	1.57
	200	202.47	209.15	193.57	198.02	195.80	199.80	1.99
	175	151.30	164.65	149.17	149.07	144.62	149.96	
Extension 2	175	188.90	198.02	178.00	182.45	180.22	185.12	2.63
	200	253.85	262.55	244.75	246.20	244.75	250.98	2.58
	225	315.94	324.84	309.27	315.94	311.49	315.60	2.88
	250	387.14	393.82	387.14	387.14	382.89	387.59	3.77
	275	473.92	486.17	482.82	478.37	478.37	481.93	7.01
	300	638.34	671.94	665.26	649.69	663.04	657.25	33.09
	325	1441.78	1530.77	1528.55	1314.95	1606.42	1484.49	
Retraction 2	325	1441.78	1530.77	1528.55	1314.95	1606.42	1484.49	41.72
	300	444.99	451.67	438.32	433.87	438.32	441.43	4.54
	275	331.52	338.19	324.84	322.62	322.62	327.96	2.22
	250	275.90	280.35	269.22	269.22	267.00	272.34	1.58
	225	233.62	242.92	229.17	231.40	228.95	232.73	1.60
	200	195.80	202.47	186.90	191.35	186.90	192.68	1.98
	175	140.17	157.97	137.85	140.17	140.17	143.29	
Extension 3	175	175.77	191.35	169.10	182.45	171.32	178.00	2.67
	200	244.75	255.87	238.07	246.97	238.07	244.75	2.47
	225	307.04	315.94	304.82	307.04	298.14	306.60	2.87
	250	380.47	391.59	373.79	376.02	369.34	378.24	3.88
	275	471.69	480.59	467.24	465.02	467.24	470.38	6.64
	300	634.11	649.69	634.11	622.89	640.79	636.34	36.65
	325	1753.27	1484.02	1419.53	1590.85	1535.22	1552.58	
Retraction 3	325	1753.27	1484.02	1419.53	1590.85	1535.22	1552.58	44.62
	300	442.77	449.44	433.87	424.97	433.87	436.98	4.43
	275	333.74	335.97	320.39	318.17	320.39	325.73	2.24
	250	275.90	278.12	264.77	264.77	264.77	269.67	1.53
	225	235.85	240.30	224.72	229.17	220.95	231.40	1.60
	200	193.57	202.47	184.67	189.12	186.90	191.35	2.05
	175	137.95	155.75	131.27	137.95	137.95	140.17	

**TABLE 8****SAMPLE 6**

		TENSION (grams)					Average (g)	Slope (g/mm)
Extension/Retraction (mm)		Specimen 1	Specimen 2	Specimen 3	Specimen 4	Specimen 5		
Extension 1	175	220.22	202.43	231.85	218.00	213.55	217.11	4.18
	200	327.00	304.75	338.12	322.55	315.88	321.66	3.87
	225	422.85	395.96	429.32	415.98	402.63	413.31	3.74
	250	520.53	487.18	527.20	507.18	491.81	506.74	4.28
	275	638.20	591.71	638.43	618.41	593.84	615.74	6.48
	300	809.71	747.43	803.04	780.79	747.43	777.58	16.75
	325	1290.20	1145.81	1221.24	1212.34	1112.24	1186.33	
Retraction 1	325	1290.20	1145.81	1221.24	1212.34	1112.24	1186.33	23.08
	300	833.98	602.83	636.20	620.63	602.83	619.30	5.00
	275	502.73	480.49	509.41	496.06	482.71	494.28	3.59
	250	411.53	391.51	418.20	407.08	393.73	404.41	3.24
	225	327.00	311.43	338.12	324.77	315.88	323.44	3.47
	200	238.02	224.67	251.37	235.79	233.57	236.68	4.02
	175	133.47	124.57	149.04	133.47	140.14	136.14	
Extension 2	175	173.51	160.16	182.41	169.06	171.28	171.28	4.25
	200	282.51	264.71	289.18	278.06	273.81	277.62	3.81
	225	371.49	353.89	387.06	389.28	358.14	387.93	3.85
	250	462.89	440.45	478.04	464.92	451.57	459.13	4.18
	275	573.92	547.22	580.59	567.24	549.45	563.68	6.05
	300	734.08	694.04	731.85	720.73	694.04	714.85	18.86
	325	1339.14	1045.51	1285.75	1183.34	1181.18	1186.98	
Retraction 2	325	1339.14	1045.51	1285.75	1183.34	1181.18	1186.98	23.19
	300	618.41	591.71	622.85	611.73	591.71	607.28	4.84
	275	496.06	471.59	500.51	487.16	478.04	486.27	3.49
	250	404.88	387.06	413.75	400.41	389.28	399.07	3.24
	225	320.33	306.98	331.45	320.33	311.43	318.10	3.47
	200	231.35	220.22	244.89	231.35	229.12	231.35	4.02
	175	129.02	120.12	142.37	129.02	133.47	130.80	
Extension 3	175	184.81	153.49	177.96	162.39	166.84	165.06	4.31
	200	271.39	258.04	289.18	278.06	268.94	272.72	3.58
	225	384.81	344.79	380.39	387.04	353.89	382.18	3.68
	250	480.47	440.45	489.37	486.02	444.90	454.24	3.97
	275	585.02	538.32	587.24	556.12	540.55	553.45	5.84
	300	718.28	678.47	718.51	702.94	680.69	699.38	17.19
	325	1118.91	1012.14	1263.50	1243.48	1007.89	1129.15	
Retraction 3	325	1118.91	1012.14	1263.50	1243.48	1007.89	1129.15	21.05
	300	613.96	585.04	618.41	605.06	591.71	602.83	4.84
	275	487.16	469.37	496.06	484.94	471.59	481.82	3.45
	250	400.41	382.61	409.30	398.18	387.06	395.51	3.19
	225	320.33	302.53	329.22	315.88	311.43	315.88	3.49
	200	229.12	218.00	240.24	229.12	226.90	228.86	4.00
	175	128.80	115.67	140.14	128.80	133.47	128.57	

**TABLE 9****SAMPLE 7**

Extension/Retraction (mm)		TENSION (grams)					Average (g)	Slope (g/mm)
		Specimen 1	Specimen 2	Specimen 3	Specimen 4	Specimen 5		
Extension 1	175	129.17	133.63	120.27	104.68	89.09	115.37	3.55
	200	213.80	227.17	211.58	189.31	178.17	204.01	2.90
	225	291.75	300.66	291.75	250.12	242.76	276.61	2.87
	250	367.48	371.93	371.93	322.93	307.34	348.32	3.47
	275	463.24	456.79	467.70	398.66	387.52	433.18	7.93
	300	708.23	652.55	677.05	572.37	550.78	633.40	17.46
	325	1080.16	1067.98	1126.93	1035.62	1008.89	1069.91	
Retraction 1	325	1080.16	1067.98	1126.93	1035.62	1008.89	1069.91	25.80
	300	474.38	454.34	464.34	385.29	380.84	429.84	4.13
	275	342.98	354.11	349.66	296.21	289.53	326.50	2.58
	250	273.94	287.30	260.82	238.30	229.39	261.91	2.48
	225	209.35	222.71	216.03	180.40	171.49	200.00	2.80
	200	138.88	151.45	140.31	118.04	104.68	130.06	3.40
	175	51.22	64.59	46.77	40.09	22.27	44.89	
Extension 2	175	86.86	95.77	73.50	69.04	46.77	74.38	3.85
	200	162.62	161.53	178.17	158.13	142.54	170.60	2.89
	225	258.35	265.03	256.12	222.71	211.58	242.76	2.87
	250	329.62	342.98	331.84	291.75	276.18	314.47	3.24
	275	412.02	423.16	420.83	385.25	356.34	395.54	7.50
	300	657.00	603.55	612.46	525.60	516.89	583.06	16.26
	325	1028.94	1055.66	1075.71	1066.80	971.03	1039.63	
Retraction 2	325	1028.94	1055.66	1075.71	1066.80	971.03	1039.63	24.85
	300	458.79	443.20	440.87	376.39	371.93	418.26	3.88
	275	338.52	347.43	342.98	291.75	285.07	321.15	2.55
	250	271.71	282.85	276.16	231.62	224.94	257.46	2.30
	225	209.35	216.26	213.80	178.17	169.26	197.77	2.90
	200	133.63	146.99	133.63	111.36	100.22	125.16	3.40
	175	46.00	57.91	42.32	33.41	17.82	40.89	
Extension 3	175	77.95	91.31	66.81	62.36	40.09	67.70	3.90
	200	173.72	184.85	171.49	153.67	142.54	163.25	3.08
	225	253.60	265.03	256.12	222.71	213.80	242.31	2.69
	250	323.16	334.07	329.62	285.07	273.94	309.57	3.10
	275	409.79	418.47	409.79	354.11	345.21	387.68	6.95
	300	632.51	581.28	587.96	505.56	496.65	560.79	18.15
	325	1013.35	1111.34	1131.36	979.94	962.12	1039.63	
Retraction 3	325	1013.35	1111.34	1131.36	979.94	962.12	1039.63	25.09
	300	449.88	438.75	436.52	371.93	365.25	412.47	3.74
	275	336.30	345.21	342.98	287.30	282.85	318.93	2.55
	250	269.48	278.39	273.94	231.62	222.71	255.23	2.41
	225	207.12	216.03	209.35	175.94	167.03	195.10	2.87
	200	131.40	144.76	133.63	111.36	95.77	123.35	3.40
	175	46.77	57.91	40.09	33.41	13.36	38.31	

Table 10

Extension / Retraction	Embedment 1		Embedment 2		Sample 1		Sample 2		Sample 3		Sample 4		Sample 5		Sample 6		Sample 7	
	Avg.	Slope	Avg.	Slope	Avg.	Slope	Avg.	Slope	Avg.	Slope	Avg.	Slope	Avg.	Slope	Avg.	Slope	Avg.	Slope
Retraction 1	175.00	113.03	2.10	116.14	2.37	186.69	2.85	-2.87	412.42	7.75	-1.76	5.50	238.52	2.63	217.11	4.16	115.37	3.55
	200.00	165.54	1.78	175.33	1.86	270.56	2.67	72.96	606.39	7.55	137.80	6.05	304.37	2.55	321.66	3.67	204.01	2.80
	225.00	210.04	1.58	224.26	1.85	337.30	2.92	189.53	795.03	9.13	339.16	6.17	368.01	3.10	413.31	3.74	278.61	2.67
	250.00	248.64	1.42	270.56	1.87	410.28	4.08	278.26	1023.28	11.66	493.41	5.32	445.44	4.30	508.74	4.36	348.32	3.47
	275.00	285.24	1.53	312.36	1.80	512.19	6.87	343.01	1314.67	15.70	628.32	8.39	553.57	6.37	619.74	6.48	435.16	7.93
Retraction 2	300.00	323.51	1.55	357.33	1.96	728.90	44.65	405.75	1707.29	19.81	761.00	4.57	762.72	36.07	777.68	16.75	633.40	17.46
	325.00	362.22	3.33	406.28	4.45	1845.15	55.37	488.48	2202.48	50.73	875.24	12.18	1684.49	48.25	1198.33	23.08	1069.81	25.60
	350.00	362.22	1.87	285.03	2.08	481.01	4.13	268.27	934.28	13.79	570.75	6.48	458.34	4.86	619.30	5.00	428.54	4.13
	275.00	232.29	1.41	242.97	1.55	357.77	2.49	160.83	569.48	7.67	408.51	5.37	338.86	2.35	484.28	3.59	328.50	2.58
	250.00	197.13	1.44	204.25	1.55	295.47	2.21	117.01	397.74	6.50	269.37	5.48	278.12	1.57	404.41	3.24	261.91	2.40
Extension 2	225.00	181.09	1.39	165.54	1.64	240.30	2.37	53.39	260.28	4.83	132.02	4.68	238.86	1.57	323.44	3.47	200.00	2.80
	200.00	126.38	2.05	124.60	2.10	181.11	2.74	-2.67	144.59	4.00	7.56	0.48	199.80	1.99	236.68	4.02	150.05	3.40
	175.00	75.20	72.09	72.09	365.78	112.58	-3.58	-3.58	44.48	44.48	-4.45	149.98	149.98	136.14	136.14	44.98	44.98	44.98
	200.00	68.77	2.14	97.22	2.28	148.96	3.03	-4.00	154.38	8.10	-4.45	2.08	165.12	2.63	171.28	4.25	74.39	3.85
	225.00	140.17	1.71	143.73	1.83	225.81	2.60	14.68	306.98	5.82	47.56	7.11	250.98	2.56	277.62	3.61	170.60	2.89
Retraction 3	250.00	182.89	1.35	189.57	1.58	290.56	2.74	113.88	452.48	8.92	225.37	6.87	315.50	2.88	387.93	3.65	242.76	2.87
	275.00	216.71	1.50	229.17	1.60	358.11	3.38	165.87	625.52	9.72	374.72	5.42	387.59	3.77	459.13	4.18	314.47	3.24
	300.00	254.09	1.57	269.22	1.82	443.68	6.87	251.37	868.44	18.18	510.30	5.87	481.93	7.01	563.68	6.05	395.54	7.50
	325.00	293.25	1.69	317.28	1.84	615.42	47.83	334.12	1273.29	28.15	858.99	6.85	657.25	33.09	714.95	18.88	583.08	16.26
	350.00	335.52	3.52	365.78	3.31	1811.12	54.45	444.90	1977.12	43.48	823.23	10.92	1494.49	41.72	1168.98	23.19	1039.53	24.85
Extension 3	325.00	335.52	2.71	365.78	3.31	1811.12	54.45	444.90	1977.12	43.48	823.23	10.92	1494.49	41.72	1168.98	23.19	1039.53	24.85
	300.00	287.89	1.76	283.02	1.86	448.88	3.93	258.93	890.24	12.94	550.30	6.37	441.43	4.54	607.28	4.84	416.26	3.88
	275.00	223.83	1.30	234.07	1.44	351.54	2.47	174.84	566.60	7.45	391.17	5.44	327.96	2.22	486.37	3.48	321.19	2.55
	250.00	191.35	1.32	198.02	1.51	288.88	2.14	109.88	380.38	5.30	255.15	5.41	272.34	1.58	399.07	3.24	257.48	2.39
	225.00	158.42	1.48	160.20	1.57	236.29	2.33	47.16	247.81	4.84	120.02	4.69	232.73	1.60	316.10	3.47	187.77	2.80
Retraction 3	200.00	121.83	1.90	121.04	2.06	178.00	2.76	-4.00	151.89	3.95	2.87	0.20	192.68	1.88	231.35	4.02	125.16	3.40
	175.00	74.31	89.42	89.42	69.42	109.02	-3.58	-3.58	32.82	32.82	-2.22	143.28	143.28	130.80	130.80	40.09	40.09	40.09
	200.00	136.61	1.76	141.06	1.82	218.05	2.89	8.34	334.36	6.25	-4.45	1.51	178.00	2.87	165.08	4.31	67.70	3.80
	225.00	180.67	1.37	186.45	1.51	285.24	2.69	103.22	431.96	6.84	33.34	7.25	244.75	2.47	272.72	3.58	165.25	3.08
	250.00	214.93	1.33	224.28	1.53	352.43	3.44	177.96	587.94	9.06	359.81	5.21	378.24	3.88	454.24	3.97	309.57	3.10
Retraction 3	275.00	248.31	1.53	262.55	1.85	438.32	6.34	239.80	824.84	15.13	489.85	5.71	470.38	6.84	553.45	5.84	387.08	6.95
	300.00	286.59	1.67	308.82	1.96	596.73	42.69	320.33	1203.00	28.09	632.54	6.70	636.34	36.85	699.36	17.19	560.78	19.15
	325.00	328.40	3.57	357.77	3.10	1694.05	43.89	438.89	1805.27	41.51	800.12	10.48	1552.58	44.62	1129.15	21.05	1039.63	25.09
	350.00	364.33	1.87	280.35	1.87	444.89	3.84	254.93	867.55	12.47	537.88	6.15	436.86	4.45	602.83	4.45	412.47	3.74
	275.00	222.50	1.30	233.62	1.46	348.87	2.58	172.17	555.87	7.39	384.06	5.41	325.73	2.24	481.82	3.45	318.93	2.55
Retraction 3	250.00	190.01	1.35	197.13	1.53	284.35	2.05	107.22	371.04	5.27	248.93	6.35	269.87	1.53	395.51	3.18	255.23	2.41
	225.00	158.18	1.41	158.68	1.58	233.18	2.30	43.60	124.57	4.59	115.13	4.59	231.40	1.60	315.88	3.48	195.10	2.87
	200.00	121.04	1.92	118.26	2.10	175.77	2.78	-3.58	124.57	3.83	0.44	0.12	191.35	2.05	228.68	4.00	123.38	3.40
	175.00	72.98	68.75	68.75	68.75	105.91	-3.11	-3.11	28.92	28.92	-2.87	140.17	140.17	129.57	129.57	38.31	38.31	38.31

Table 11

Extension / Retraction Cycle	Embodiment 1			Embodiment 2			Sample 1			Sample 2			Sample 3			Sample 4			Sample 5			Sample 6			Sample 7		
	Ext. Range	Ave. Slope	Ext. Slope	Ext. Range	Ave. Slope	Ext. Slope	Ext. Range	Ave. Slope	Ext. Slope	Ext. Range	Ave. Slope	Ext. Slope	Ext. Range	Ave. Slope	Ext. Slope	Ext. Range	Ave. Slope	Ext. Slope	Ext. Range	Ave. Slope	Ext. Slope	Ext. Range	Ave. Slope	Ext. Slope	Ext. Range	Ave. Slope	Ext. Slope
Extension 1	175-325	1.66	1.93	175-325	1.93	1.93	175-325	10.99	3.14	175-325	3.14	175-325	11.93	175-325	5.85	175-325	9.51	175-325	6.53	175-325	6.53	175-325	6.53	175-325	6.53	175-325	6.53
	200-325	1.57	1.85	200-325	1.85	1.85	200-325	12.60	3.16	200-325	3.16	200-325	12.77	200-325	5.90	200-325	10.88	200-325	7.00	200-325	7.00	200-325	7.00	200-325	7.00	200-325	7.00
	225-325	1.52	1.82	225-325	1.82	1.82	225-325	15.08	2.78	225-325	2.78	225-325	14.07	225-325	5.36	225-325	12.96	225-325	7.83	225-325	7.83	225-325	7.83	225-325	7.83	225-325	7.83
	250-325	1.50	1.81	250-325	1.81	1.81	250-325	19.13	2.56	250-325	2.56	250-325	15.72	250-325	5.09	250-325	16.25	250-325	9.19	250-325	9.19	250-325	9.19	250-325	9.19	250-325	9.19
Retraction 1	275-325	1.54	1.88	275-325	1.88	1.88	275-325	26.68	2.51	275-325	2.51	275-325	17.78	275-325	4.98	275-325	22.22	275-325	11.61	275-325	11.61	275-325	11.61	275-325	11.61	275-325	11.61
	300-325	1.55	1.96	300-325	1.96	1.96	300-325	44.65	2.51	300-325	2.51	300-325	19.61	300-325	4.57	300-325	36.07	300-325	16.73	300-325	16.73	300-325	16.73	300-325	16.73	300-325	16.73
	175-325	1.91	2.23	175-325	2.23	2.23	175-325	11.55	3.15	175-325	3.15	175-325	14.39	175-325	5.86	175-325	10.10	175-325	7.07	175-325	7.07	175-325	7.07	175-325	7.07	175-325	7.07
	200-325	1.89	2.25	200-325	2.25	2.25	200-325	13.31	3.77	200-325	3.77	200-325	18.46	200-325	6.94	200-325	11.72	200-325	7.68	200-325	7.68	200-325	7.68	200-325	7.68	200-325	7.68
Extension 2	225-325	2.01	2.41	225-325	2.41	2.41	225-325	16.05	4.15	225-325	4.15	225-325	19.42	225-325	7.43	225-325	14.26	225-325	8.73	225-325	8.73	225-325	8.73	225-325	8.73	225-325	8.73
	250-325	2.20	2.69	250-325	2.69	2.69	250-325	20.66	4.69	250-325	4.69	250-325	24.06	250-325	8.08	250-325	18.48	250-325	10.58	250-325	10.58	250-325	10.58	250-325	10.58	250-325	10.58
	275-325	2.60	3.27	275-325	3.27	3.27	275-325	29.75	5.76	275-325	5.76	275-325	32.26	275-325	9.33	275-325	26.55	275-325	14.04	275-325	14.04	275-325	14.04	275-325	14.04	275-325	14.04
	300-325	3.33	4.45	300-325	4.45	4.45	300-325	55.37	8.01	300-325	8.01	300-325	50.73	300-325	12.18	300-325	48.25	300-325	23.08	300-325	23.08	300-325	23.08	300-325	23.08	300-325	23.08
Retraction 2	175-325	1.66	1.86	175-325	1.86	1.86	175-325	11.07	2.99	175-325	2.99	175-325	12.15	175-325	5.52	175-325	8.66	175-325	6.77	175-325	6.77	175-325	6.77	175-325	6.77	175-325	6.77
	200-325	1.58	1.78	200-325	1.78	1.78	200-325	12.68	3.44	200-325	3.44	200-325	13.36	200-325	6.21	200-325	9.87	200-325	7.27	200-325	7.27	200-325	7.27	200-325	7.27	200-325	7.27
	225-325	1.71	1.96	225-325	1.96	1.96	225-325	15.21	3.31	225-325	3.31	225-325	15.25	225-325	5.88	225-325	11.69	225-325	8.19	225-325	8.19	225-325	8.19	225-325	8.19	225-325	8.19
	250-325	1.92	2.24	250-325	2.24	2.24	250-325	19.36	3.45	250-325	3.45	250-325	18.02	250-325	5.98	250-325	14.63	250-325	9.70	250-325	9.70	250-325	9.70	250-325	9.70	250-325	9.70
Extension 3	275-325	2.23	2.63	275-325	2.63	2.63	275-325	27.35	3.87	275-325	3.87	275-325	22.17	275-325	6.26	275-325	20.05	275-325	12.47	275-325	12.47	275-325	12.47	275-325	12.47	275-325	12.47
	300-325	2.71	3.31	300-325	3.31	3.31	300-325	47.83	4.43	300-325	4.43	300-325	28.15	300-325	6.65	300-325	33.09	300-325	18.88	300-325	18.88	300-325	18.88	300-325	18.88	300-325	18.88
	175-325	1.63	1.83	175-325	1.83	1.83	175-325	11.35	2.89	175-325	2.89	175-325	12.96	175-325	5.50	175-325	8.94	175-325	7.04	175-325	7.04	175-325	7.04	175-325	7.04	175-325	7.04
	200-325	1.71	1.96	200-325	1.96	1.96	200-325	13.08	3.59	200-325	3.59	200-325	14.76	200-325	6.56	200-325	10.33	200-325	7.65	200-325	7.65	200-325	7.65	200-325	7.65	200-325	7.65
Retraction 3	225-325	1.77	2.06	225-325	2.06	2.06	225-325	15.75	3.98	225-325	3.98	225-325	17.29	225-325	7.03	225-325	12.52	225-325	8.69	225-325	8.69	225-325	8.69	225-325	8.69	225-325	8.69
	250-325	1.92	2.24	250-325	2.24	2.24	250-325	20.29	4.47	250-325	4.47	250-325	21.29	250-325	7.57	250-325	16.16	250-325	10.51	250-325	10.51	250-325	10.51	250-325	10.51	250-325	10.51
	275-325	2.23	2.63	275-325	2.63	2.63	275-325	29.19	5.40	275-325	5.40	275-325	28.21	275-325	8.84	275-325	23.13	275-325	14.01	275-325	14.01	275-325	14.01	275-325	14.01	275-325	14.01
	300-325	2.71	3.31	300-325	3.31	3.31	300-325	54.45	7.44	300-325	7.44	300-325	43.48	300-325	10.92	300-325	41.72	300-325	23.19	300-325	23.19	300-325	23.19	300-325	23.19	300-325	23.19
Retraction 3	175-325	1.63	1.83	175-325	1.83	1.83	175-325	10.15	2.94	175-325	2.94	175-325	11.81	175-325	5.36	175-325	8.16	175-325	6.43	175-325	6.43	175-325	6.43	175-325	6.43	175-325	6.43
	200-325	1.53	1.73	200-325	1.73	1.73	200-325	11.57	3.42	200-325	3.42	200-325	12.91	200-325	6.13	200-325	10.46	200-325	6.85	200-325	6.85	200-325	6.85	200-325	6.85	200-325	6.85
	225-325	1.48	1.71	225-325	1.71	1.71	225-325	13.79	3.34	225-325	3.34	225-325	14.73	225-325	5.85	225-325	12.46	225-325	7.67	225-325	7.67	225-325	7.67	225-325	7.67	225-325	7.67
	250-325	1.51	1.78	250-325	1.78	1.78	250-325	17.49	3.45	250-325	3.45	250-325	17.43	250-325	5.87	250-325	15.66	250-325	9.00	250-325	9.00	250-325	9.00	250-325	9.00	250-325	9.00
Retraction 3	275-325	1.60	1.90	275-325	1.90	1.90	275-325	24.51	3.94	275-325	3.94	275-325	21.61	275-325	6.21	275-325	21.64	275-325	11.51	275-325	11.51	275-325	11.51	275-325	11.51	275-325	11.51
	300-325	1.67	1.96	300-325	1.96	1.96	300-325	42.69	4.66	300-325	4.66	300-325	28.09	300-325	6.70	300-325	36.65	300-325	17.19	300-325	17.19	300-325	17.19	300-325	17.19	300-325	17.19
	175-325	1.70	1.91	175-325	1.91	1.91	175-325	10.39	2.93	175-325	2.93	175-325	12.51	175-325	5.35	175-325	9.42	175-325	6.67	175-325	6.67	175-325	6.67	175-325	6.67	175-325	6.67
	200-325	1.66	1.91	200-325	1.91	1.91	200-325	11.91	3.52	200-325	3.52	200-325	14.25	200-325	6.40	200-325	10.89	200-325	7.20	200-325	7.20	200-325	7.20	200-325	7.20	200-325	7.20
Retraction 3	225-325	1.72	1.99	225-325	1.99	1.99	225-325	14.31	3.93	225-325	3.93	225-325	16.68	225-325	6.85	225-325	13.21	225-325	8.13	225-325	8.13	225-325	8.13	225-325	8.13	225-325	8.13
	250-325	1.85	2.14	250-325	2.14	2.14	250-325	18.40	4.40	250-325	4.40	250-325	20.46	250-325	7.35	250-325	17.11	250-325	9.78	250-325	9.78	250-325	9.78	250-325	9.78	250-325	9.78
	275-325	2.12	2.48	275-325	2.48	2.48	275-325	26.30	5.28	275-325	5.28	275-325	26.99	275-325	8.32	275-325	24.54	275-325	12.95	275-325	12.95	275-325	12.95	275-325	12.95	275-325	12.95
	300-325	2.56	3.10	300-325	3.10	3.10	300-325	48.78	7.28	300-325	7.28	300-325	41.51	300-325	10.49	300-325	44.62	300-325	21.05	300-325	21.05	300-325	21.05	300-325	21.05	300-325	21.05

Table 12

Extension / Retraction Cycle	Embodiment 1		Embodiment 2		Sample 1		Sample 2		Sample 3		Sample 4		Sample 5		Sample 6		Sample 7	
	Ext.	Rang.	Ext.	Rang.	Ext.	Rang.	Ext.	Rang.	Ext.	Rang.	Ext.	Rang.	Ext.	Rang.	Ext.	Rang.	Ext.	Rang.
Average Over	175-325	1.72	175-325	1.96	175-325	10.92	175-325	3.02	175-325	12.62	175-325	5.37	175-325	9.30	175-325	6.75	175-325	6.57
First Three	200-325	1.65	200-325	1.91	200-325	12.52	200-325	3.49	200-325	14.09	200-325	6.36	200-325	10.69	200-325	7.27	200-325	7.17
Cycles	225-325	1.67	225-325	1.96	225-325	15.03	225-325	3.58	225-325	16.24	225-325	6.42	225-325	12.85	225-325	8.21	225-325	8.24
	250-325	1.76	250-325	2.08	250-325	19.22	250-325	3.84	250-325	19.50	250-325	6.66	250-325	16.38	250-325	9.79	250-325	10.11
	275-325	1.95	275-325	2.35	275-325	27.29	275-325	4.46	275-325	24.83	275-325	7.29	275-325	23.02	275-325	12.77	275-325	13.71
	300-325	2.25	300-325	2.79	300-325	48.96	300-325	5.72	300-325	35.29	300-325	8.58	300-325	40.07	300-325	20.02	300-325	21.74
Average Over	175-325	1.65	175-325	1.87	175-325	10.74	175-325	3.02	175-325	11.96	175-325	5.58	175-325	9.11	175-325	6.58	175-325	6.43
First Three	200-325	1.56	200-325	1.79	200-325	12.28	200-325	3.34	200-325	13.01	200-325	6.08	200-325	10.40	200-325	7.04	200-325	6.96
Extensions	225-325	1.51	225-325	1.77	225-325	14.69	225-325	3.15	225-325	14.68	225-325	5.73	225-325	12.37	225-325	7.90	225-325	7.96
	250-325	1.53	250-325	1.80	250-325	18.66	250-325	3.16	250-325	17.06	250-325	5.65	250-325	15.51	250-325	9.30	250-325	9.67
	275-325	1.59	275-325	1.90	275-325	26.17	275-325	3.44	275-325	20.51	275-325	5.81	275-325	21.30	275-325	11.86	275-325	12.88
	300-325	1.64	300-325	1.95	300-325	45.06	300-325	3.87	300-325	25.35	300-325	5.97	300-325	35.27	300-325	17.61	300-325	18.29
Average Over	175-325	1.79	175-325	2.05	175-325	11.10	175-325	3.02	175-325	13.29	175-325	5.37	175-325	9.48	175-325	6.93	175-325	6.72
First Three	200-325	1.75	200-325	2.04	200-325	12.76	200-325	3.63	200-325	15.16	200-325	6.63	200-325	10.98	200-325	7.51	200-325	7.39
Retractions	225-325	1.83	225-325	2.15	225-325	15.37	225-325	4.02	225-325	17.79	225-325	7.10	225-325	13.33	225-325	8.52	225-325	8.52
	250-325	1.99	250-325	2.36	250-325	19.78	250-325	4.52	250-325	21.94	250-325	7.67	250-325	17.25	250-325	10.28	250-325	10.55
	275-325	2.32	275-325	2.79	275-325	28.41	275-325	5.48	275-325	29.15	275-325	8.77	275-325	24.74	275-325	13.67	275-325	14.55
	300-325	2.87	300-325	3.62	300-325	52.86	300-325	7.58	300-325	45.24	300-325	11.20	300-325	44.86	300-325	22.44	300-325	25.18

**TABLE 13**

Extension (mm)	DECAY (grams)									
	EMBODIMENT 1	EMBODIMENT 2	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5	SAMPLE 6	SAMPLE 7	
175	40.05	48.39	90.78	0.44	383.50	0.89	98.34	88.53	77.06	
200	44.50	56.07	94.78	75.52	481.82	157.35	113.03	92.98	80.62	
225	53.84	65.41	104.13	145.93	555.67	224.03	138.61	97.43	81.51	
250	59.63	73.42	125.93	169.06	652.22	244.48	175.77	111.22	83.09	
275	62.74	76.76	163.31	170.84	758.99	242.26	227.84	133.91	116.26	
300	59.18	76.98	283.91	150.82	839.74	223.14	325.73	174.84	220.83	
Average	53.32	66.67	143.81	118.94	611.89	178.69	179.55	118.49	111.59	



Table 1 represents Embodiment 1 described above, and which generally corresponds to elongate elastic member 66 (Fig.2) being joined to elongate sleeve member 62 at locations corresponding to seams 34 (Fig. 1). Table 2 represents Embodiment 2, which is similar to Embodiment 1, except that in Embodiment 2 the elastic member is selectively intermittently joined to the elongate sleeve member. The intermittent pattern of joining is a pattern of 1.27 centimeter (0.5 inch) wide adhesive zones separated by 1.27 centimeter wide zones with no adhesive. Table 3 represents Sample 1, Table 4 represents Sample 2, Table 5 represents Sample 3, Table 6 represents Sample 4, Table 7 represents Sample 5, Table 8 represents Sample 6, and Table 9 represents Sample 7.

The below-described test procedure was applied to five specimen elastic waistbands of five products of each of the Embodiments 1-2 Samples 1-7 to generate the data in Tables 1-13. After describing the test procedure, one example of a calculation will be provided.

#### Test Procedure

This test procedure is entitled "SINTECH TESTWORKS® Cycle Testing Program for Elastomeric Waistbands." The test procedure involves the following equipment:

- (1) Sintech and TestWorks® version 2.11 software with a tensile tester with an equivalent computerized data-acquisition system, and a 25 pound load cell. Although this test procedure is designed for the Sintech TestWorks® system, it can be performed with other test systems that can be programmed to calculate the required parameters.

(2) User's Guide for Sintech TestWorks™ Program,

5 (3) Peg/pin fixtures that are clamped into each of the two pneumatic grips/jaws of the Sintech Tester, with one of the fixtures on the movable block at the top, and the other fixture on the stationary block at the bottom.

Specimen preparation requires that used product, or product that has been  
10 tested for other purposes, not be used. A finished product is required, in which "finished product" refers to a product manufactured to be used for its intended purpose, such as a product removed from a bag purchased from any suitable facility, such as a grocery store. With the finished product in the retracted state, the elastic waistband is cut off from the  
15 top of the waist opening so that the cut-off portion includes the full width of the elastic member or element, and ensuring that the full length of the waistband maintains its closed-loop form, i.e., ensuring the waistband is not cut through its circumferential length. It was sufficient for the elastic waistbands to be cut 2.38 centimeters (15/16  
20 inch) in width at the waist opening, ensuring that the elastic waistband included the full width of the elastic member or element.

The test parameters for the procedure are as follows:

- 25 (1) a crosshead speed of 500 millimeters per minute,
- (2) a gage length of 150 millimeters, and

- (3) waist tension values, in grams, taken at designated 25 millimeter increments in the extension range of 150 millimeters to 325 millimeters.

5 The procedure for preparing the test equipment is as follows:

- (1) Verify the 25 pound load cell is in the Sintech Tester. The load cell must warm up a minimum of 30 minutes.

- 10 (2) Boot up the Sintech, and if necessary, type in the operator identification and press Enter. Use the arrow keys or mouse to highlight the heading desired.

- (3) Highlight "Test" on the main menu, and press Enter.

15

- (4) Highlight "Method" on the Test Menu, and press Enter.

- (5) Highlight "CSD Standard", and press Enter.

- 20 (6) Highlight "Cycle Test 150-325 mm", and press Enter.

- (7) Highlight "Test" from the Test Menu, and press Enter.

- (8) Enter the Sample identification code, and press Enter.

25

- (9) Clamp into each of the two pneumatic grips/jaws of the Sintech Tester the pin/peg fixtures, with one on the movable block at the top, and the other on the stationary block at the bottom. Ensure

that the upper and lower pin/peg fixtures are vertically aligned.  
Press "T" to tare load and weight of fixtures.

- 5 (10) Press F9. Adjust the fixture distance to 150 millimeters from the  
top end of the top fixture to the bottom end of the lower fixture.  
To accomplish this, press "G" for crosshead movement and indicate  
the number of millimeters needed to obtain the 150 millimeter gage  
length. Press "Z" for zero extension. Press Escape for the Test  
Menu.
- 10 (11) Highlight "Calibrate" for calibration, and press Enter. Follow the  
TestWorks® menu program for calibration of the load cell, with  
reference to the User Guide for more information on Load Cell  
Calibration if necessary. The load cell must be calibrated whenever  
15 the load cell is changed, and at the beginning of each day/shift.
- (12) Press Escape when calibration is completed to return to the Test  
Menu.
- 20 The testing steps are as follows:
- (1) Place the closed-loop elastic waistband area onto the grooved  
section of the top pin/peg fixture at the seamed portion of the  
elastic waistband, and press F9.
- 25 (2) Press "T" to tare the load.
- (3) Press Escape to return to the Test Menu.

- (4) Place the other end of the waistband on the bottom pin/peg fixture, with one seam on the top fixture and the other seam on the bottom fixture.

5

- (5) Highlight "Run", and press Enter. The test will start and stop automatically, and will return to the 150 millimeter gage length at completion.

- 10 (6) When the run is completed, highlight either "File" if data and graphs are to be saved, or "Next" to save only the data. Using either "File" or "Next" will bring up the "Test" screen for the next specimen. Remove the waistband from the tester.

- 15 (7) Repeat steps 1-6 for the five specimens until the testing is complete.

- (8) Refer to the User's Guide for Sintech TestWorks protocol to export data into an appropriate spreadsheet software package.

20

This test procedure was performed on Embodiments 1 and 2 and Samples 1-7. By way of example with reference to Table 9, five elastic waistband specimens from five products of Sample 7 (Oyasumi Man product) were individually run through the first three cycles. The tension in grams at  
25 25 millimeter increments between 175-325 millimeters is presented in the first five columns of Table 9 under the heading "TENSION (gms)". At each 25 mm increment for the five specimens, the five tensions in grams were averaged and appear in the "Average" column. Then, for example, by

subtracting the average tension of 204.01 grams at 200 millimeters of Extension 1 from the average tension of 115.37 grams at 175 millimeters of Extension 1, and dividing that difference by the 25 millimeter increment, there results an average slope of 3.55 grams per millimeter between 175 millimeters to 200 millimeters in Extension 1; this 3.55 slope value appears in the "Slope (g/mm)" column. Similar average slopes were calculated for all of the 25 millimeter increments in the first three cycles.

10 Table 10 presents the data from the "Average" and "Slope" columns of Tables 1-9 for Embodiments 1 and 2, and Samples 1-7.

Table 11 presents the average slopes (g/mm) at selected extension ranges and retraction ranges for the extensions and retractions of the first three cycles. For example, Sample 7 has an average slope of 6.36 g/mm in the extension range of 175-325 millimeters for the extension of the first cycle; the first cycle including Extension 1 and Retraction 1. Similarly, for the retraction of the first cycle in the 175-325 millimeter range, Sample 7 has an average slope of 6.83 g/mm. These values are calculated from the data in Table 10. For example, in Table 11, the average slope of 6.36 g/mm for Sample 7 in the extension range of 175-325 millimeters of the first cycle is calculated by averaging, from Table 10, the six slope values for Sample 7 between 175 millimeters and 325 millimeters for Extension 1.

25

From the data in Table 11, there is calculated for Embodiments 1-2 and Samples 1-7, an overall average slope for (1) the first three cycles, (2) the three extensions of the first three cycles, and (3) the three

retractions of the first three cycles within specific ranges. These overall average slopes are presented in Table 12. For example, Embodiment 1 has an overall average slope over the first three cycles of about 1.96 grams per millimeter in the range of 175-325 millimeters. The slope of 1.96 g/mm is calculated by averaging the slope of 1.98 g/mm over the first three extensions and the slope of 2.05 g/mm over the first three retractions. As can be clearly seen in Table 12, Embodiments 1-2 have much lower overall average slopes for the first three cycles, the first three extensions, and the first three retractions, than Samples 1-7. These overall average slopes in Table 12 are termed average maximum rates of change of modulus of the elasticity over the first three cycles within the identified range.

By providing lower average maximum rates of change of modulus of elasticity over the first three cycles, there is provided a substantially uniform low tension over a wide size range, a more comfortable fit, and improved ease of use.

Training pant 20 can be made of any suitable materials well known in the field of personal care absorbent articles. For example, absorbent structure 38 can comprise any suitable absorbent material, natural or synthetic, or a combination thereof, along with superabsorbent material. The absorbent material of which absorbent structure is made may also be encased in a tissue wrap (not shown) in order to maintain the integrity of the absorbent material. Suitable superabsorbent materials are available from various vendors, such as Stockhausen, Inc., Dow Chemical Company, Hoechst-Celanese Corporation, and Allied Colloids, Inc. Typically, the superabsorbent material is capable of absorbing at least

- about 15 times its weight in water, and desirably is capable of absorbing more than about 25 times its weight in water. A suitable natural absorbent material is a wood pulp fluff identified by the trade designation CR 1654 from Kimberly-Clark Corporation, Neenah, Wisconsin.
- 5 This particular wood pulp fluff is a bleached, highly absorbent sulfate wood pulp fluff containing soft wood fibers.

- Outer cover layer 46 may be a single layer of a liquid permeable or liquid impermeable material, and may or may not have breathability, i.e.,
- 10 be vapor permeable. In this particular embodiment, outer cover layer 46 is a two-layer composite comprising outer layer 50 and inner layer 52. Outer layer 50 is a liquid permeable, nonwoven bicomponent web having a basis weight between about 15 to about 35 gsm. The nonwoven bicomponent web may be a spunbond bicomponent web, or a bonded carded bicomponent
- 15 web. Suitable bicomponent fibers are a wettable, polyethylene/polypropylene bicomponent fiber available from CHISSO Corporation, Osaka, Japan. In this particular bicomponent fiber, the polypropylene forms the core and the polyethylene forms the sheath of the fiber. Other fiber orientations are possible, such as multi-lobe,
- 20 side-by-side, or end-to-end. An alternative suitable material is a liquid permeable spunbond polypropylene nonwoven web having a basis weight between about 15 gsm to about 50 gsm.

- Inner layer 52 is desirably a 0.0015 centimeter polyethylene film from
- 25 Edison Plastics Company, Newport News, Virginia.

Liner 48 is a liquid permeable, substantially hydrophobic material, such as a spunbonded web, meltblown web, bonded carded web of synthetic



polymer filaments, or combined synthetic filaments with natural fibers, such as rayon. Suitable synthetic polymers include, by way of example, polyethylene, polypropylene, and polyester. Liner 48 typically has a pore size that readily allows the passage of liquids, such as urine and other body exudates. If desired, liner 48 can be treated with a surfactant to selectively adjust its degree of wettability, and can also be selectively embossed or perforated with discrete slits or holes. Liner 48 desirably has a basis weight between about 10 gsm to about 30 gsm.

10

All of the described adhesives, such as adhesives 54, 56, 72, 74, can be any adhesives suitable for joining the identified materials. Suitable adhesives can be obtained from Findley Adhesives, Inc., Wauwatosa, Wisconsin, or obtained from National Starch and Chemical Co., Bridgewater, N.J. The adhesives can be applied in any manner, such as by spraying, slot-coat extrusion, printing, or the like. The applied adhesive can be in any desired configuration, such as continuous or discontinuous beads, continuous or discontinuous swirls, meltblown patterns, spray patterns, or the like.

20

Elongate sleeve member 62 of waist elastic system 60 can be a nonwoven bicomponent web comprising about 50 percent polypropylene fibers and 50 percent polyethylene fibers in a side-by-side orientation, and having a basis weight of about 17 gsm. This particular type of material can be purchased from BASF Corporation, Charlotte, N.C. Other materials suitable for use in elongate sleeve member 62 include a 13 gsm spunbond polypropylene web, or a 13 gsm spunbond polyester web.

25

Elastic member 66 is desirably made of natural rubber, or an elastomeric material such as isoprene purchasable from JPS Elastomerics Company, Holyoke, Maine. Elastic member 66, as earlier described above, can be a single ribbon of material, or a plurality of strands or ribbons of  
5 elastic material. A desired material for use as a plurality of strands of elastic are LYCRA® 940 decitex, which can be purchased from E.I. DuPont de Nemours Company, Wilmington, Delaware.

Another important factor in providing a substantially uniform low tension  
10 over a wide size range, a more comfortable fit, and improved ease of use, is the maximum magnitude of decay, measured in grams of tension, at a specific extension over the first three cycles. For ease of explanation and understanding, and by way of example, the following description is made with reference to Figure 9. The first three cycles of Embodiment 1  
15 are identified as cycle 1, cycle 2, and cycle 3. Decay over the first three cycles 1, 2, and 3 is calculated by selecting an extension, for example 300 millimeters, and identifying the extension curve E1 for cycle 1 and the retraction curve R3 for cycle 3, and then subtracting the tension in grams at E1 from the tension in grams at R3. This difference  
20 represents the decay, ie. the loss of tension in grams, over the first three cycles at an extension of 300 millimeters.

Similarly, and continuing with reference to Fig. 9, Sample 3 is represented by cycle 1', cycle 2', and cycle 3'. The decay over the  
25 first three cycles for Sample 3, measured at an extension of 300 millimeters, is the difference in grams at extension E1' of cycle 1' and the retraction R3' of cycle 3'. Fig. 9 clearly illustrates that the

decay over the first three cycles of Embodiment 1 is significantly less than the decay over the first three cycles of Sample 3.

With reference to Table 13, the decay of Embodiments 1-2 and Samples 1-7 are tabulated at 25 millimeter increments in the range of 175 millimeters to 300 millimeters. At an extension of 300 millimeters, for example, Embodiment 1 results in a decay of 59.18 grams over the first three cycles, and Embodiment 2 results in a decay of 76.98 grams over the first three cycles. These decay values are significantly lower than the decay values at 300 millimeters for Samples 1-7. For example, at an extension of 300 millimeters, Sample 2 has a decay over the first three cycles of 150.82 grams, and Sample 3 has a decay over the first three cycles of 839.74 grams.

Referring now primarily to Figs. 5 and 6, one method will be described of a manufacturing assembly line for making a disposable absorbent training pant 20. In Fig. 5, a first layer 80 of a material having opposite edge portions 84, 86 is continuously moved in a first direction 82. The first layer 80 can be supplied in any suitable manner well known in the art, and subsequently will form part of elongate sleeve member 62 (Fig. 2). An elongate elastic member 88 is continuously applied or provided in first direction 82, in any suitable manner well known in the art, in a selectively tensioned state to first layer 80. Elongate elastic member 88 will subsequently form part of elongate elastic member 66 (Fig. 2). Elongate elastic member 88 can also be continuously applied or provided in a substantially untensioned manner, and, if so, it may be a specific type of elastomeric material commonly referred to as a heat-elasticizable material. This latter type of elastomeric material can be treated, such

as by heat, to recover its latent elasticity. Generally, elongate elastic member 88 will be joined to first layer 80, prior to the folding of first layer 80, by a pulsed adhesive system 90 for providing a predetermined adhesive pattern on first layer 80 by selectively  
5 controlling a bank of spray nozzles 91. The adhesive may be sprayed or applied in a continuous pattern or an intermittent pattern. One system suitable for use is the pulsed adhesive system described in European Patent Application 0 603 748 A1, the contents of which are incorporated by reference herein. The adhesive can also be supplied in other suitable  
10 manners, such as by extrusion slot coating or by a patterned adhesive roll (not shown).

The pulsed adhesive system 90 can apply adhesive in any desired pattern. For example, pulsed adhesive system 90 can apply an adhesive pattern,  
15 such as adhesive zone 92 (Fig. 5) having a window 93 that is void of adhesive. Another adhesive pattern that can be applied by pulsed adhesive system 90 is represented by adhesive zones 95 which extend substantially across first layer 80 in a direction transverse to first direction 82. Yet another adhesive pattern is illustrated by adhesive  
20 zones 99 which are applied intermittently and more closely spaced together than adhesive zones 95. Regardless of the adhesive pattern utilized, it is desired that the pattern be selected such that at least a portion of the adhesive pattern will correspond in location to seams 34 (Fig. 1) of training pant 20.

25

Alternatively, the application of adhesive can be eliminated, and elongated elastic member 88 can be joined to first layer 80 in a subsequent bonding step that results in seams 34, as will be described

hereafter. In this case, elongate elastic member 88 will be joined to first layer 80 after folding first layer 80.

After providing elongate elastic member 88 to first layer 80, first layer  
5 80 passes through a folding board 94, which continuously folds first layer 80 in a direction generally transverse to first direction 82 along a fold line 96 and over elongate elastic member 88. Upon being folded, elongate elastic member 88 is intermittently joined to first layer 80, thereby resulting in a first elastic composite 97, which will ultimately  
10 form a part of elongate sleeve member 62 (Fig. 2).

A second elastic composite 112 (Fig. 6) can be made in a separate manufacturing assembly line in the same manner as first elastic composite 97. These two elastic composites 97, 112 can be made in a parallel  
15 manner to each other, or angularly oriented to each other, depending upon various factors, such as facility accommodations, i.e., the size of the building housing the apparatus, material supply requirements, operator requirements, or the like. After first and second elastic composites 97, 112 have been made, they can be individually wound on rolls, and  
20 transported to another assembly line, such as that in Fig. 6, for subsequent handling.

Referring now to Fig. 6, a base layer 98 having opposite edge portions 102, 104 is continuously moved in a machine direction 100. Base layer  
25 98 may be a single layer of material, or a laminate or composite comprising, for example in this description, two layers that ultimately form outer layer 50 and inner layer 52 (Fig. 2). Base layer 98 may also be made of a material suitable for use as liner 48. A pair of adhesive

applicators, such as adhesive spray nozzles 106, apply adhesives, such as adhesives 74 (Fig. 2), along opposite edge portions 102, 104.

5 A plurality of absorbent structures 38 are registered or provided on top of base layer 98 at equidistantly spaced apart locations between the opposite edge portions 102, 104. Absorbent structures 38 are positioned on base layer 98 such that their respective lengths 42 are transverse to machine direction 100. This orientation of absorbent structures 38 also results in their respective widths 44 being transverse to the cross  
10 direction 101. Each length 42 is greater in dimension than a width 44. The absorbent structures 38 can be provided in any suitable manner known in the art.

A top layer 108 is continuously supplied on top of absorbent structures  
15 38 and base layer 98. Just as base layer 98 may be made of a material or layers of material suitable for outer cover layer 46 or liner 48, top layer 108 may also be made of materials suitable for use as outer cover layer 46 or liner 48. In this particular description, top layer 108 is the liner. First elastic composite 97 and second elastic composite 112  
20 are continuously delivered to base layer 98 so as to be positioned on respective edge portions 102, 104, and are joined thereto by adhesive beads 74 (Fig. 2). A pressure roller 110 presses elastic composites 97, 112, base layer 98, and, if desired, top layer 108, together to assist in joining the layers together. Top layer 108 may be smaller in transverse  
25 width than base layer 98, and thus may not be in contact with elastic composites 97, 112. The elastic composites 97, 112 will form elongate sleeve member 62 (Fig. 2).

Elastic composites 97, 112 may be joined to either side of base layer 98. For example, Fig. 6 illustrates the elastic composites 97, 112 joined on the same side of base layer 98 on which absorbent structures 38 are placed. If desired, elastic composites 97, 112 can be joined on the  
5 opposite side of base layer 98, thereby resulting in the embodiment in Fig. 2.

A patterned rotary die, such as patterned cutting roll 114, cuts a plurality of openings 116 through top layer 108 and base layer 98,  
10 between absorbent structures 38. Openings 116 will subsequently form leg openings 32 (Fig. 1). If desired, openings 116 can be formed by other means, such as by water-jet cutters, and may be cut into any desired form.

15 Thereafter, a folding board 118 folds base layer 98 along a fold line 120 that is parallel to the machine direction 100. A rotary ultrasonic bonder 122 then bonds the folded base layer 98 along a plurality of bond lines 124, which are generally transverse to machine direction 100. The bonding along bond lines 124 forms seams 34 (Fig. 1), and may be  
20 continuous or intermittent along one or a plurality of lines. The bond lines 124 are located between absorbent structures 38, and if desired can simultaneously bond each elongate elastic member 88 (Fig. 5) to its respective layer 80 (Fig. 5). In this latter case, it may be unnecessary to apply any adhesive to first layer 80 (Fig. 5).

25

A cutting roll 126 having a blade 128 cuts base layer 98 along cut lines 130 that are transverse to machine direction 100 and between absorbent structures 38. Desirably, cut lines 130 are located within a central

region or area of respective bond lines 124, thereby splitting a single bond line 124 into two bond lines. The cutting of base layer 98 results in a plurality of disposable absorbent training pants 20 having waist elastic systems 60 about waist openings 30, and leg openings 32 formed by  
5 seams 34.

In the above-described process, elastic composites 97, 112 are material independent of chassis 22. Thus, elastic composites 97, 112 can be made of any desired materials, and materials different from any materials of  
10 which chassis 22 is made, to provide a waist elastic system 60 having desired elastic properties.

Fig. 3 illustrates a modification of waist elastic system 60 is integral or unitary with chassis 22 (Fig. 1). In this description, structural  
15 elements in common with those in Fig. 2 will retain the same reference numerals. Waist border 36 (Fig. 3) comprises outer layer 50 and inner layer 52. A peripheral edge portion 58 of outer layer 50 extends outwardly, i.e., further to the right as illustrated in Fig. 3, beyond the ends of inner layer 52 and liner 48. Peripheral edge portion 58  
20 extends sufficiently to permit it to be folded upon itself to form an elongate sleeve member 132. Sleeve member 132 comprises an outer surface 134, an inner surface 136, and defines an elongate passage 138 having elongate elastic member 140 disposed therein.

25 This construction of waist elastic system 60 provides similar advantages and benefits previously described with reference to Fig. 2. With regard to these constructions, the elongate sleeve members 62, 132 can be disposed on the outermost side of outer layer 50 or the innermost side of



outer layer 50. For example, in Fig. 2, both outer surface 68 and inner surface 70 of elongate sleeve member 62 can be disposed on the opposite side, the lower side as viewed in Fig. 2, of outer layer 50.

Furthermore, if desired, outer surface 68 and inner surface 70 can have peripheral edge portion 58 sandwiched therebetween. With reference to Fig. 3, peripheral edge portion 58 can be folded upon itself in a direction opposite to that illustrated in Fig. 3, such that outer surface 134 is on the opposite side, the lower side as viewed in Fig. 3, of peripheral edge portion 58. Generally, the construction and placement of waist elastic system 60 with reference to peripheral edge portion 58 will be determined by several factors, such as material factors, manufacturing factors, aesthetic factors, or the like.

With reference to Fig. 4, a description will be made of one method for making the modification in Fig. 3. A base layer 142 having opposite edge portions 146, 148 is continuously moved in a machine direction 144. Base layer 142 may be any of the layers previously described with reference to chassis 22. For example, base layer 142 may be selected to eventually comprise outer cover layer 46, liner 48, or any other layer that may be incorporated in chassis 22. In this particular description, base layer 142 is selected to be outer cover layer 46 comprising an outer layer 50 and an inner layer 52.

A plurality of absorbent structures 38 are registered or provided on top of base layer 142 in an equidistantly spaced-apart manner. Each absorbent structure 38 has a length dimension 42 greater than a width dimension 44, and is oriented on base layer 142 such that length dimension 42 is generally transverse to machine direction 144. The

absorbent structures 38 are also, as illustrated in Fig. 4, positioned between opposite edge portions 146, 148 of base layer 142.

- A top layer 150, such as a liner material in this description, is continuously supplied, in any suitable manner well known in the art, to overlay the absorbent structures 38 and base layer 142, and a plurality of openings 116 are cut or formed in a manner such as that earlier described with reference to Fig. 6.
- 10 Top layer 150 has opposite edge portions 151, 153 which, like opposite edge portions 146, 148 of base layer 142, extend in the machine direction 144. As described above, base layer 142 forms outer cover layer 46 comprising outer layer 50 and inner layer 52 (Fig. 3), and outer layer 50 extends laterally beyond opposite edge portions 151, 153 of top layer
- 15 150. "Laterally beyond" refers to a direction parallel to cross direction 168, which is transverse to machine direction 144. It is this extension of outer layer 50 that will form a part of waist elastic system 60.
- 20 In Fig. 4, two differently patterned adhesive rolls 152, 158 are illustrated for purposes of description intermittently applying different adhesive patterns to base layer 142. However, it is understood that generally only one adhesive pattern will be selected.
- 25 Patterned adhesive roll 152 intermittently applies adhesive in machine direction 144 in a selected adhesive pattern 154 to opposite edge portion 146 of base layer 142. Adhesive pattern 154 includes a plurality of distinct adhesive zones 156 which are spaced apart from one another,

i.e., intermittently applied, in the machine direction 144. If desired, only distinct adhesive zones 156 can be applied by patterned adhesive roll 152, thereby eliminating any connecting adhesive pattern between the adhesive zones 156. As will be described hereafter, it is the distinct  
5 adhesive zones 156 that adhesively join an elongate elastic member 140. The remaining adhesive of adhesive pattern 154 will adhesively join a folded portion of opposite edge portion 146. If preferred, a pulsed adhesive system, similar to pulsed adhesive system 90 in Fig. 5, can replace patterned adhesive rolls 152, 158. Regardless of the apparatus  
10 and method of applying adhesives, it is important that the process and apparatus be capable of applying the adhesive in a selectively intermittent pattern.

Patterned adhesive roll 158 applies an optional adhesive pattern 160  
15 having a plurality of spaced-apart distinct adhesive zones 162. In comparison to adhesive zones 156, adhesive zones 162 are more closely spaced together. The spacing of adhesive zones 156, 162, as well as their dimensions, can be dependent upon numerous variables, such as the adhesive material, the amount of adhesive applied, the elastic material,  
20 the layer materials, manufacturing speeds, or the like.

An elongate elastic member 140 is continuously delivered, in machine direction 144, to each edge portion 146, 148 of base layer 142. In this particular description, these opposite edge portions 146, 148 correspond  
25 to, in the finished product, peripheral edge portion 58 (Fig. 3) of outer layer 50. Each elongate elastic member 140 can be applied either with a selected tension, or substantially untensioned, in a manner similar to that described with reference to the method in Fig. 6.

As illustrated in Fig. 4, each of the elongate elastic members 140 are delivered or positioned on base layer 142 such that they overlies adhesive zones 156 in opposite edge portion 146, or adhesive zones 162 in opposite edge portion 148. This results in an intermittent joining of elastic members 140 in their respective edge portions 146, 148.

After elongate elastic members 140 have been delivered to base layer 142, a pair of folding boards 164 fold each opposite edge portion 146, 148 along their respective fold lines 166. This causes each opposite edge portion 146, 148 to be folded in a direction parallel to cross direction 168, and over a respective elongate elastic member 140. Opposite edge portions 146, 148 will eventually form, in a finished training pant 20, an elongate sleeve member 62 (Fig. 2).

15

After passing through folding boards 164, base layer 142 can be processed in a manner similar to that in Fig. 6. For example, a folding board 118 folds base layer 142 along fold line 170, which is generally parallel to machine direction 144. An ultrasonic bonder, such as rotary ultrasonic bonder 122, ultrasonically bonds folded base layer 142 along a plurality of bond lines 172, generally transverse to machine direction 144. A cutting roll 126 then cuts base layer 142 along a plurality of cut lines that lie between absorbent structures 38 and that are generally transverse to machine direction 144. The cutting of folded base layer 142 forms individual disposable absorbent training pants 20 (Fig. 1) with respective waist elastic systems 60 (Fig. 2) about waist openings 30, and leg openings 32 formed from seams 34.

While this invention has been described as having preferred embodiments, it will be understood that it is capable of further modifications. This application is therefore intended to cover any variations, equivalents, uses or adaptations of the invention following the general principles thereof, and including such departures from the present disclosure as  
5 come within known or customary practice in the art to which this invention pertains and falls within the limits of the appended claims.

What is claimed is:

1. A waist elastic system for a disposable absorbent pant comprising a chassis including a front panel, a back panel, a crotch panel, and an absorbent structure on said crotch panel, said front panel and said back panel being selectively joined to form a waist opening and a pair of leg openings, said waist elastic system comprising:

an elongate sleeve member defining an elongate passage therein, and being generally peripherally disposed about said waist opening, and

an elongate elastic member disposed within said elongate passage,

said waist elastic system having a maximum magnitude of decay of about 125 grams at an extension of about 300 millimeters over the first three cycles.

2. The waist elastic system of claim 1 wherein said maximum magnitude of decay is about 76.98 grams.

3. The waist elastic system of claim 2 wherein said maximum magnitude of decay is about 59.18 grams.

4. The waist elastic system of claim 1 wherein said elongate elastic member comprises an outermost peripheral edge and an innermost peripheral edge, and

wherein said absorbent structure comprises an absorbent end edge,

said innermost peripheral edge of said elongate elastic member being spaced from said absorbent end edge between about 5 millimeters to about 20 millimeters.

5. The waist elastic system of claim 1 wherein said chassis is a multi-layer chassis comprising at least two layers,

one of said layers having a peripheral edge portion at said waist opening and being folded upon itself to form said elongate sleeve member.

6. The waist elastic system of claim 5 wherein said one layer is a nonwoven layer.

7. A waist elastic system for a disposable absorbent pant comprising a chassis including a front panel, a back panel, a crotch panel, and an absorbent structure on said crotch panel, said front panel and said back panel being selectively joined to form a waist opening and a pair of leg openings, said waist elastic system comprising:

an elongate sleeve member defining an elongate passage therein, and being generally disposed about said waist opening, and

an elongate elastic member disposed within said elongate passage,

said waist elastic system having a maximum magnitude of decay of about 90 grams at an extension of about 250 millimeters over the first three cycles.

8. The waist elastic system of claim 7 wherein said maximum magnitude of decay is about 73.42 grams.

9. The waist elastic system of claim 8 wherein said maximum magnitude of decay is about 59.63 grams.

10. The waist elastic system of claim 7 wherein said elongate elastic member comprises an outermost peripheral edge and an innermost peripheral edge, and

5        wherein said absorbent structure comprises an absorbent end edge, said innermost peripheral edge of said elongate elastic member being spaced from said absorbent end edge between about 5 millimeters to about 20 millimeters.

11. The waist elastic system of claim 7 wherein said chassis is a multi-layer chassis comprising at least two layers,

      one of said layers having a peripheral edge portion at said waist opening and being folded upon itself to form said elongate sleeve member.

12. The waist elastic system of claim 11 wherein said one layer is a nonwoven layer.

13. A waist elastic system for a disposable absorbent pant comprising a chassis including a front panel, a back panel, a crotch panel, and an absorbent structure on said crotch panel, said front panel and said back panel being selectively joined to form a waist opening and a pair of leg openings, said waist elastic system comprising:

5        an elongate sleeve member defining an elongate passage therein, and being generally peripherally disposed about said waist opening, and  
      an elongate elastic member disposed within said elongate passage,  
      said waist elastic system having a maximum magnitude of decay of  
10        about 70 grams at an extension of about 200 millimeters over the first three cycles.



14. The waist elastic system of claim 13 wherein said maximum magnitude of decay is about 56.07 grams.

15. The waist elastic system of claim 14 wherein said maximum magnitude of decay is about 44.50 grams.

16. The waist elastic system of claim 13 wherein said elongate elastic member comprises an outermost peripheral edge and an innermost peripheral edge, and

5        wherein said absorbent structure comprises an absorbent end edge, said innermost peripheral edge of said elongate elastic member being spaced from said absorbent end edge between about 5 millimeters to about 20 millimeters.

17. The waist elastic system of claim 13 wherein said chassis is a multi-layer chassis comprising at least two layers,

      one of said layers having a peripheral edge portion at said waist opening and being folded upon itself to form said elongate sleeve member.

18. The waist elastic system of claim 17 wherein said one layer is a nonwoven layer.

19. A disposable absorbent pant comprising:

5        a chassis including a front panel, a back panel, a crotch panel, and an absorbent structure on said crotch panel, said front and said back panel being joined together to form a waist opening and a pair of leg openings,

said chassis further including a waist border comprising a layer of material generally peripherally disposed about said waist opening, and  
a waist elastic system generally peripherally joined to said waist border, said waist elastic system having a maximum magnitude of decay of  
10 about 90 grams at an extension of about 250 millimeters over the first three cycles.

20. The pant of claim 19 wherein said maximum magnitude of decay is about 73.42 grams.

21. The pant of claim 20 wherein said waist elastic system comprises an elongate sleeve member having an elongate passage therein, and an elastic member disposed within said elongate passage.

22. The pant of claim 21 wherein said layer of material is a nonwoven material.

23. The pant of claim 22 wherein said absorbent structure has an absorbent end edge, and

wherein said elastic member has an outermost peripheral edge and an innermost peripheral edge,

5 said innermost peripheral edge being spaced from said absorbent end edge between about 5 millimeters to about 20 millimeters.

24. The pant of claim 23 wherein said elastic member is a single elastic member.

25. The pant of claim 23 wherein said elastic member is a plurality of elastic members.

26. In a disposable absorbent pant comprising a chassis including a front panel and a back panel joined together to form a waist opening and a pair of leg openings, a crotch panel, and an absorbent structure disposed on said crotch panel;

5       a waist elastic system having a maximum magnitude of decay of about 150 grams at an extension of about 300 millimeters over the first three cycles.

27. The pant of claim 26 wherein said maximum magnitude of decay is about 76.98 grams.

28. The pant of claim 27 wherein said maximum magnitude of decay is about 59.18 grams.

29. The pant of claim 26 wherein said waist elastic system comprises an elongate sleeve member defining an elongate passage therein, and being generally peripherally joined about said waist opening, and an elongate elastic member disposed within said elongate passage.

30. The pant of claim 29 wherein said absorbent structure has an absorbent end edge, and

wherein said elongate elastic member has an outermost peripheral edge and an innermost peripheral edge,

5       said innermost peripheral edge being spaced from said absorbent end edge between about 5 millimeters to about 20 millimeters.

31. The pant of claim 30 wherein said elongate elastic member is a single elastic member.

32. The pant of claim 30 wherein said elongate elastic member is a plurality of elastic members.

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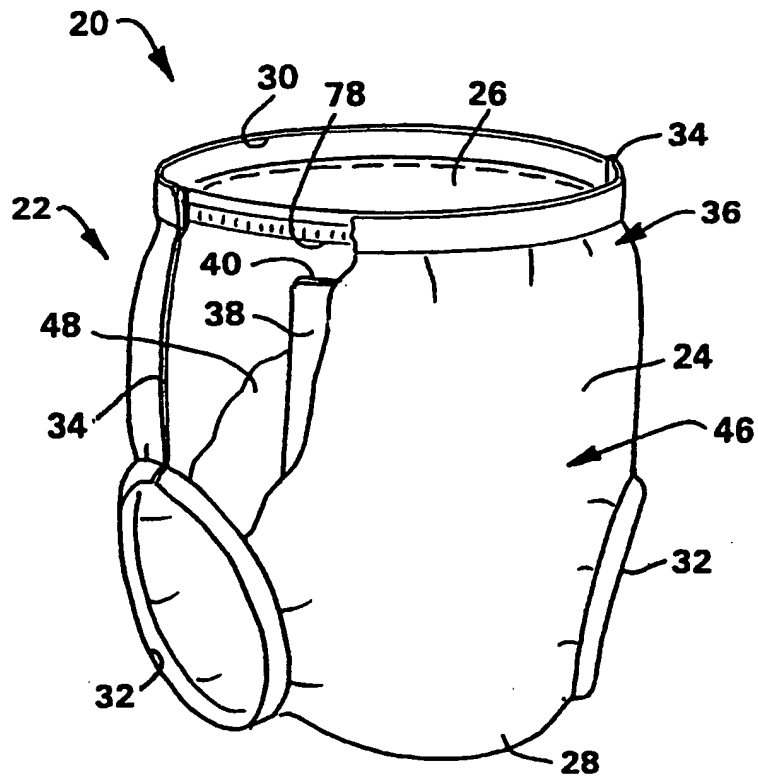


FIG. 1

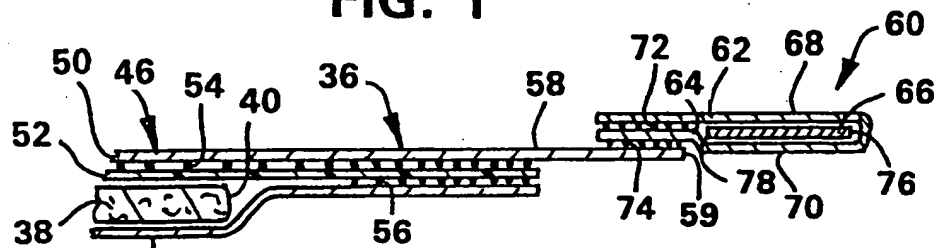


FIG. 2

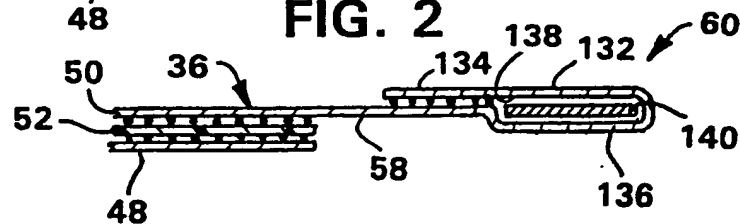
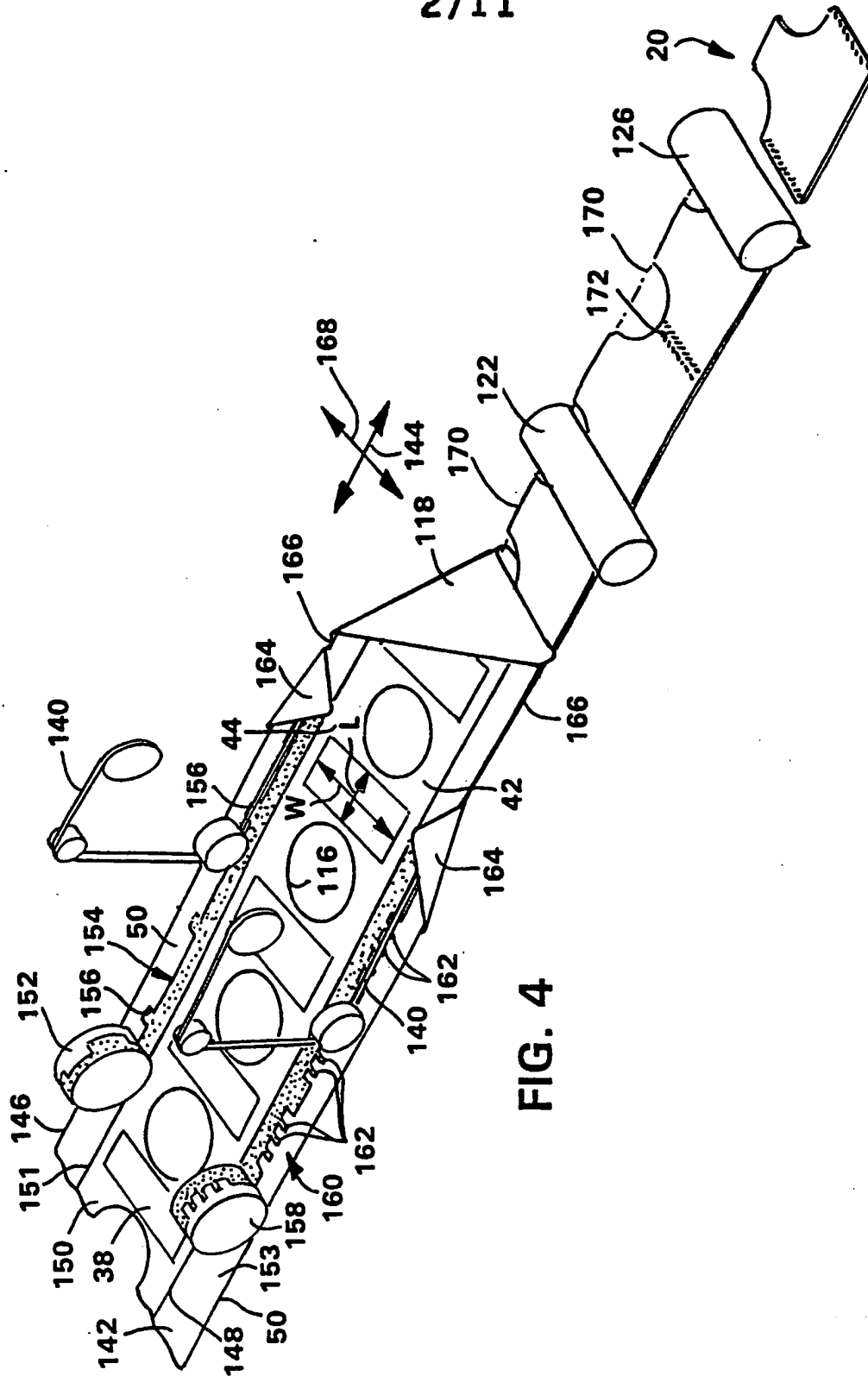
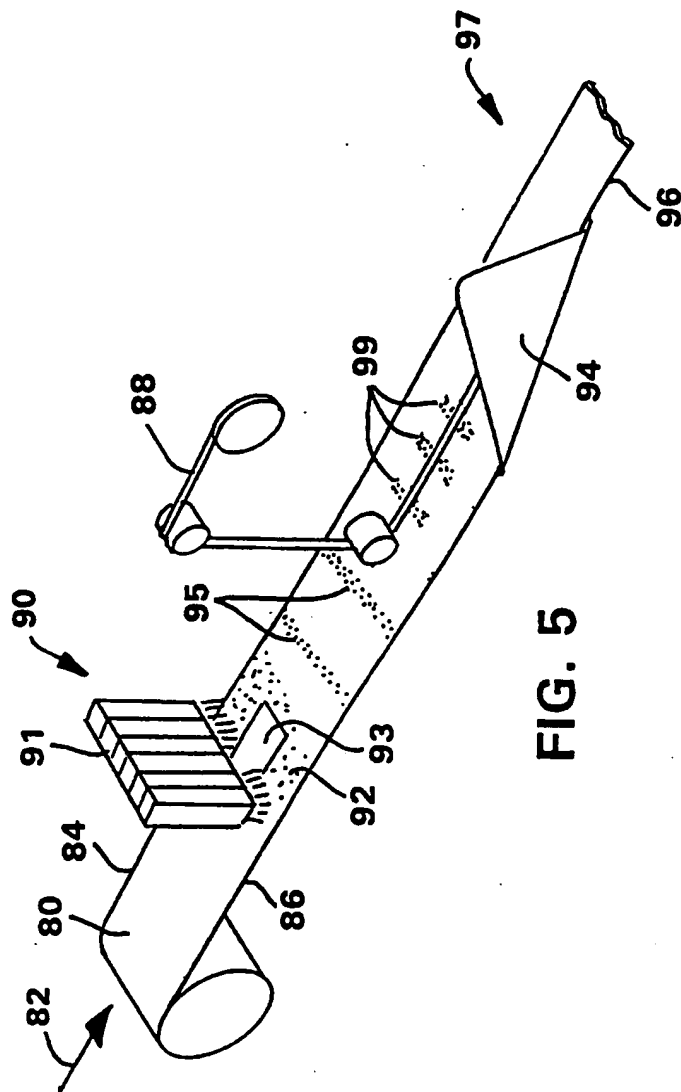


FIG. 3

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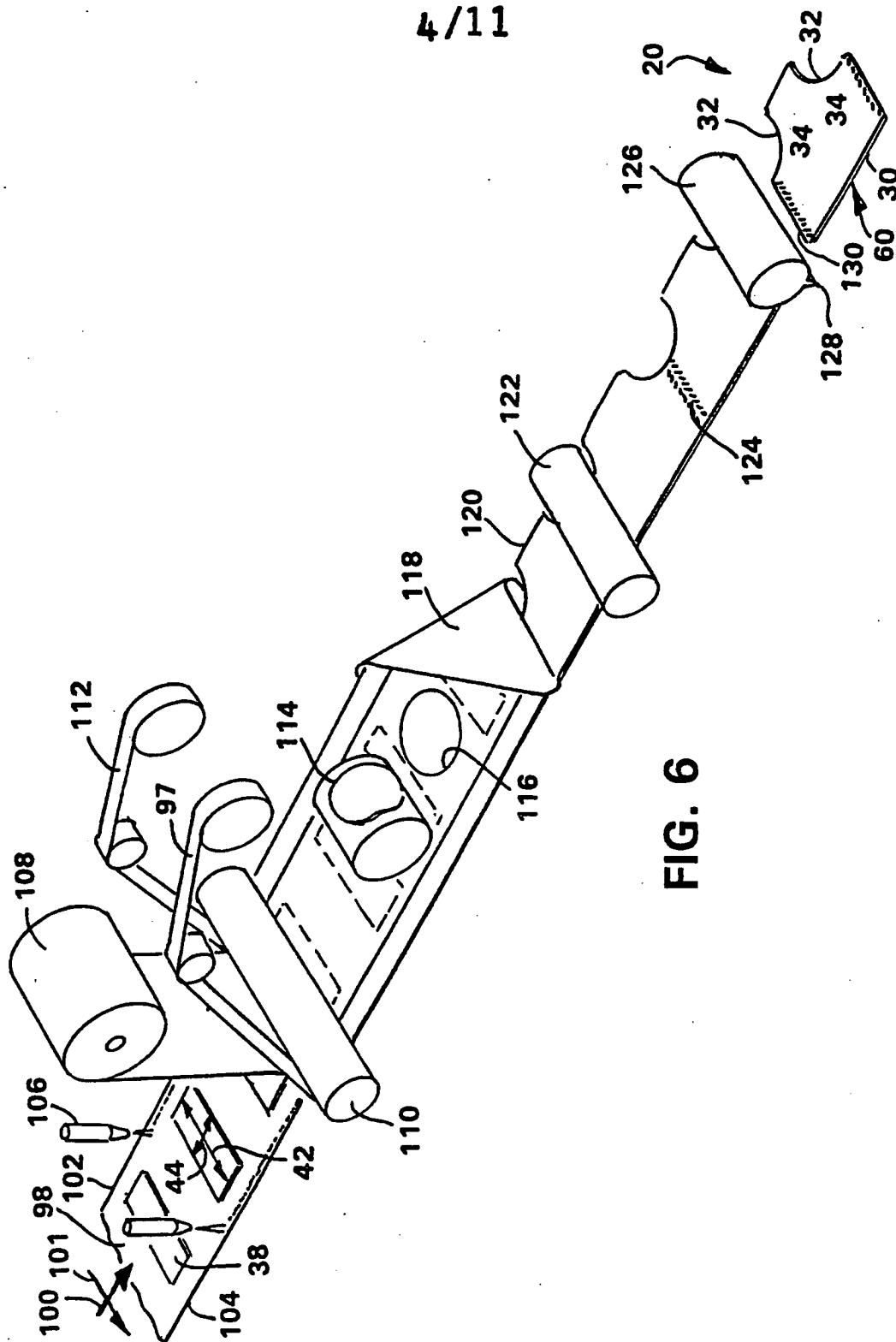
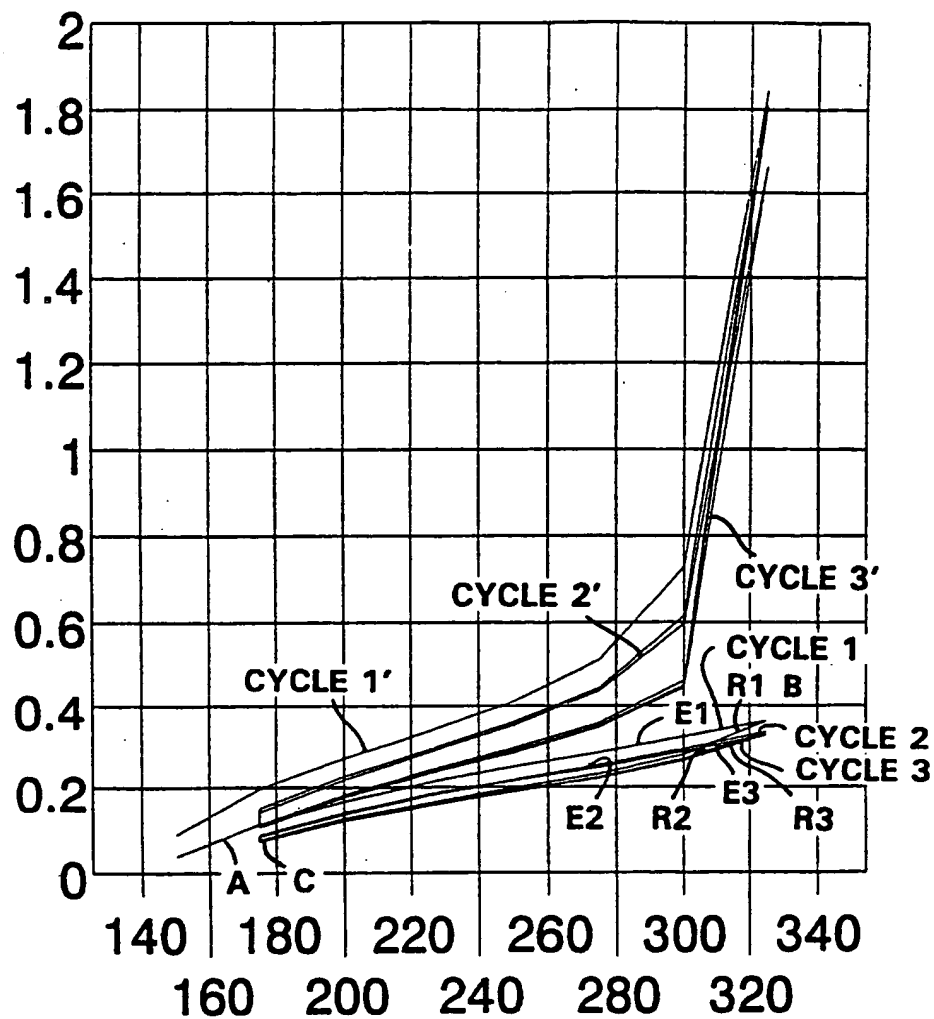


FIG. 6



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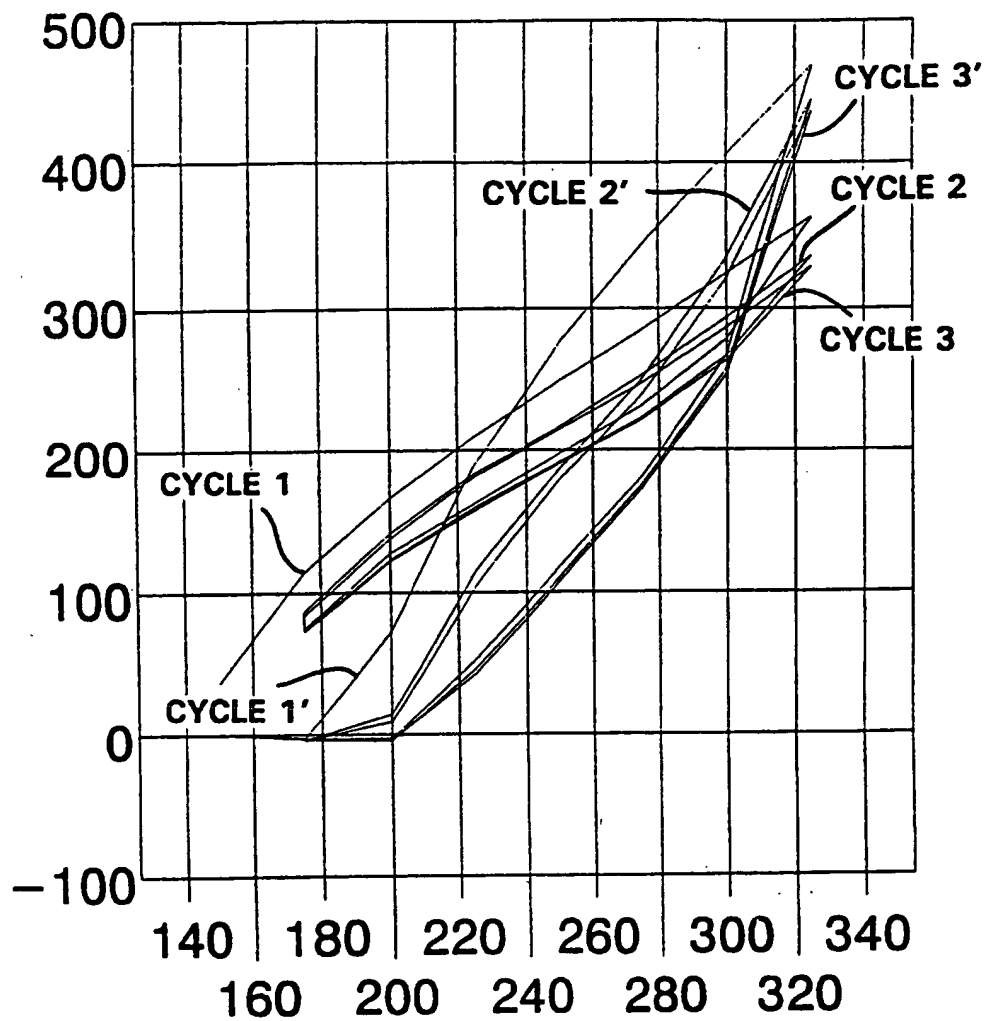
TENSION (GRAMS)  
(THOUSANDS)

EXTENSION (mm)

FIG. 7

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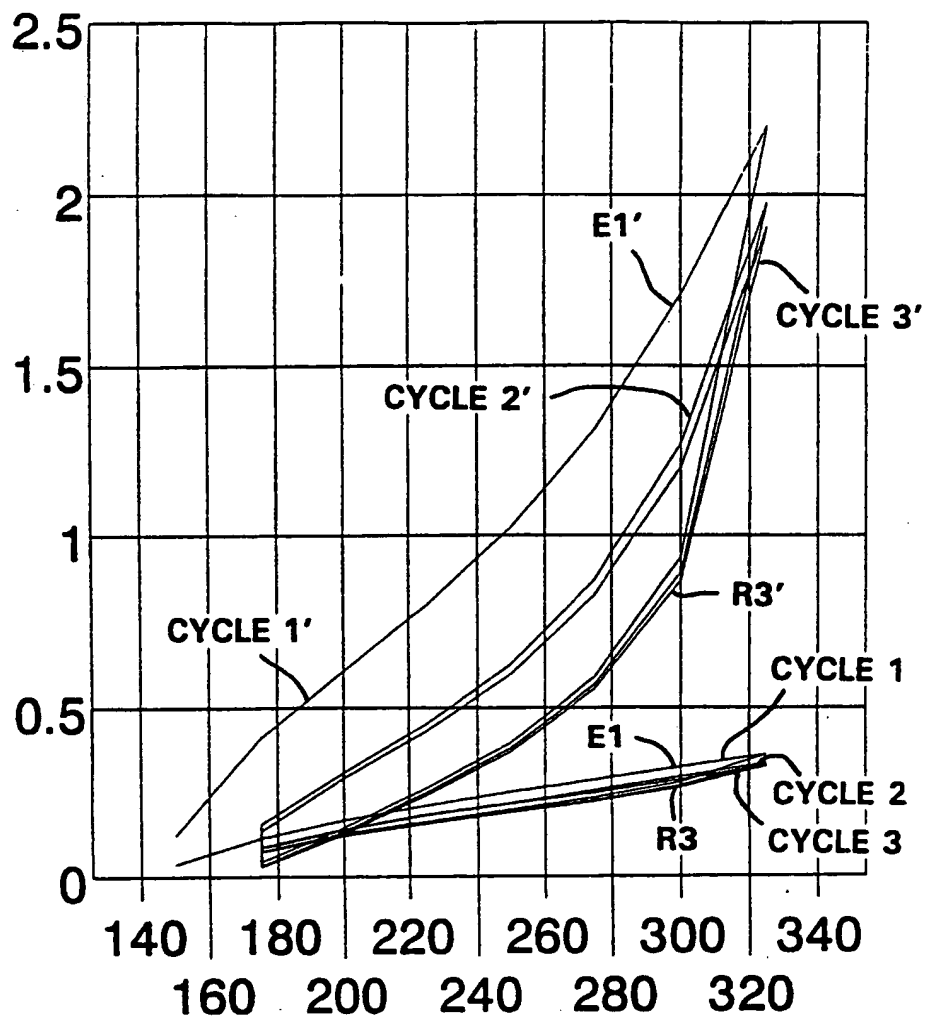
TENSION (GRAMS)



EXTENSION (mm)

FIG. 8

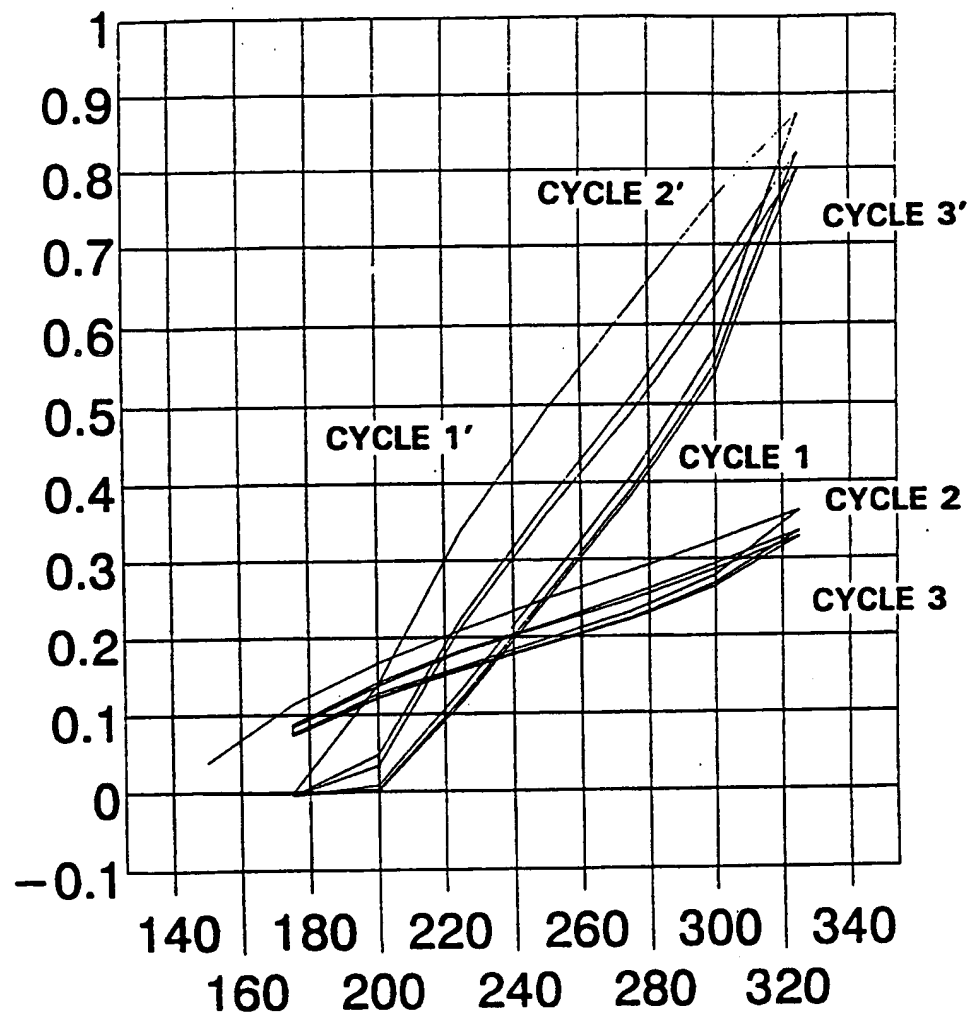
7/11

TENSION (GRAMS)  
(THOUSANDS)

EXTENSION (mm)

FIG. 9

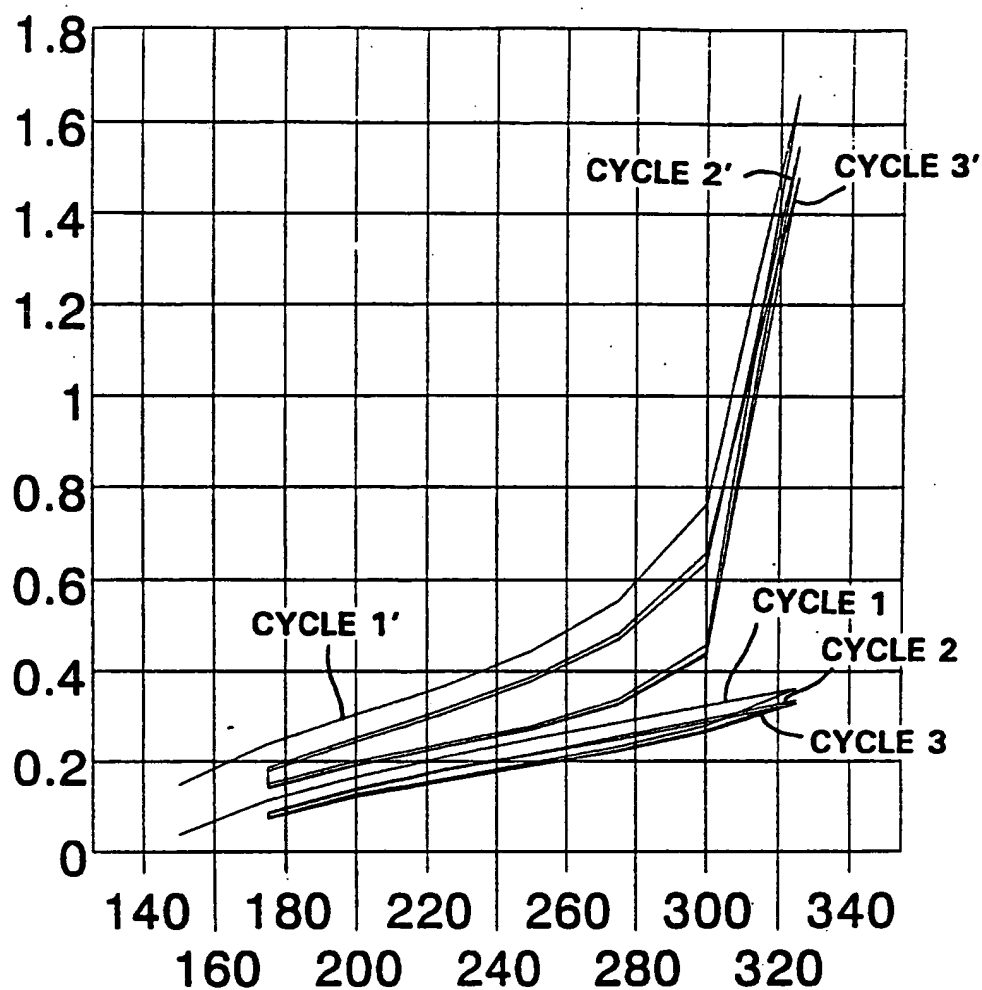
8/11

TENSION (GRAMS)  
(THOUSANDS)

EXTENSION (mm)

FIG. 10

9/11

TENSION (GRAMS)  
(THOUSANDS)

EXTENSION (mm)

FIG. 11

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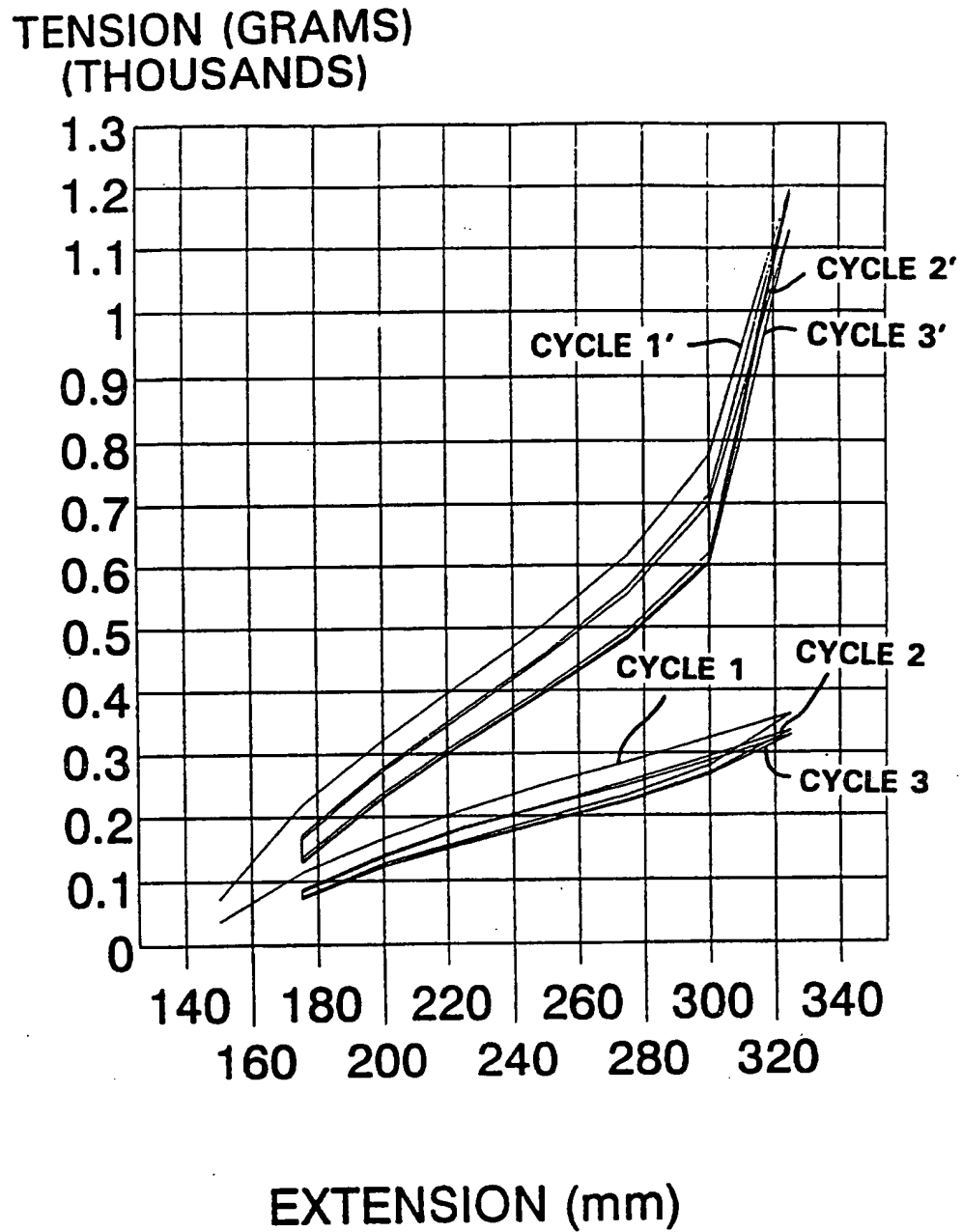
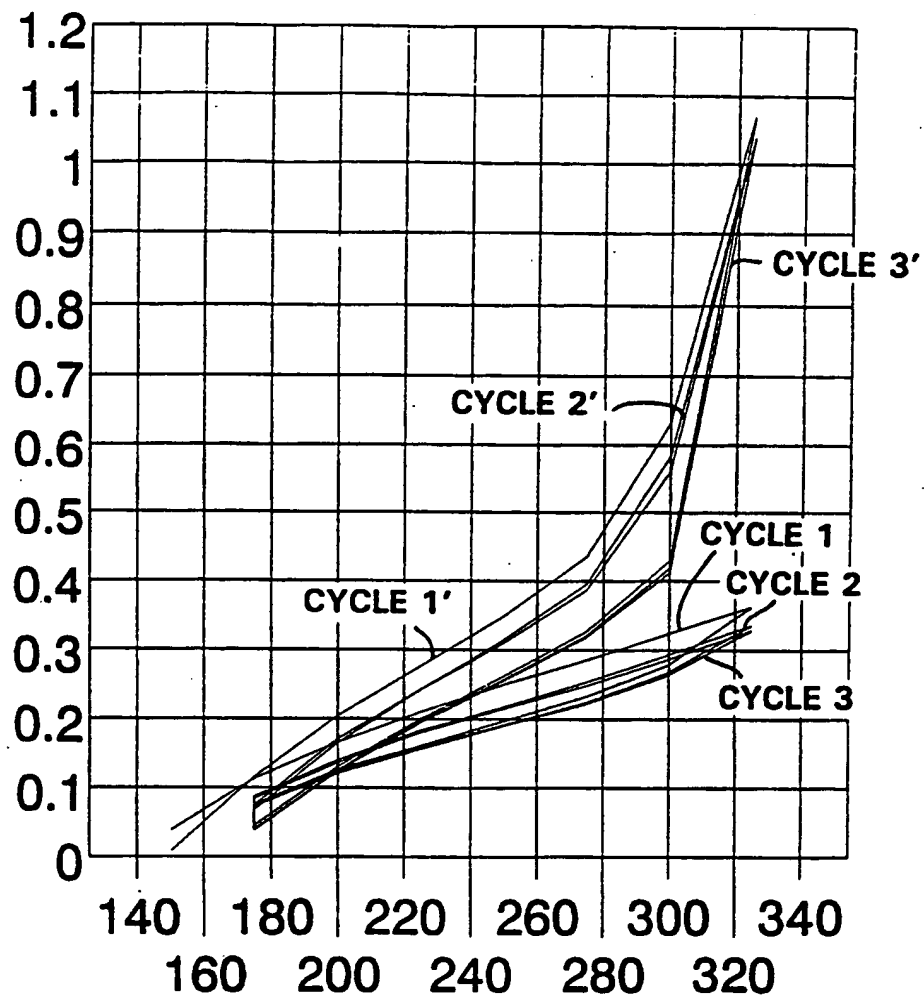


FIG. 12

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TENSION (GRAMS)  
(THOUSANDS)

EXTENSION (mm)

FIG. 13

# INTERNATIONAL SEARCH REPORT

Inter- national Application No  
PCT/US 96/06896

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 A61F13/15

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO,A,94 28845 (PARAGON TRADE BRANDS INC) 22 December 1994 see page 9, line 7 - line 20; figures 8,9 ---	1,7,13, 19,26
A	WO,A,95 00096 (PROCTER & GAMBLE) 5 January 1995 see page 16, line 12 - page 17, line 18 ---	1,7,13, 19,26
A	US,A,4 735 622 (ACUFF ANDILA C ET AL) 5 April 1988 see abstract ---	1,7,13, 19,26
A	EP,A,0 320 991 (KIMBERLY CLARK CO) 21 June 1989 see the whole document ---	1,7,13, 19,26
A	US,A,5 074 845 (MIRAKI MANOUCHEHR ET AL) 24 December 1991 ---	
-/--		

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

30 September 1996

Date of mailing of the international search report

09. 10. 96

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Authorized officer

Sánchez y Sánchez, J



# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US 96/06896

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB,A,2 283 662 (MOELNLYCKE AB) 17 May 1995 -----	

# INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

PCT/US 96/06896

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A-9428845	22-12-94	JP-A- 6343660	20-12-94
WO-A-9500096	05-01-95	AU-A- 7059994	17-01-95
		CA-A- 2165288	05-01-95
		EP-A- 0705088	10-04-96
US-A-4735622	05-04-88	NONE	
EP-A-0320991	21-06-89	AU-A- 2698688	22-06-89
		CA-A- 1326328	25-01-94
		CA-A- 1329864	31-05-94
		DE-D- 3889435	09-06-94
		DE-T- 3889435	01-09-94
		DE-U- 8817215	14-07-94
		DE-U- 8817217	11-08-94
		EP-A- 0597331	18-05-94
		ES-T- 2051825	01-07-94
		JP-A- 2004364	09-01-90
		KR-Y- 9308207	13-12-93
		KR-Y- 9308208	13-12-93
		KR-Y- 9308209	13-12-93
		US-A- 4940464	10-07-90
		US-A- 4938757	03-07-90
US-A-5074845	24-12-91	CA-A- 2019886	18-01-91
		DE-D- 69015272	02-02-95
		DE-T- 69015272	10-08-95
		EP-A- 0409436	23-01-91
		JP-A- 3070575	26-03-91
GB-A-2283662	17-05-95	AU-A- 1080095	06-06-95
		CA-A- 2175924	26-05-95
		EP-A- 0729339	04-09-96
		FI-A- 962038	14-05-96
		NO-A- 961973	25-06-96
		SE-A- 9303746	16-05-95
		WO-A- 9513781	26-05-95